THE REPERTORY OF ARTS AND MANUFACTURES:

CONSISTING OF

ORIGINAL COMMUNICATIONS,

SPECIFICATIONS OF PATENT INVENTIONS,

AND

SELECTIONS OF USEFUL PRACTICAL PAPERS

FROM THE

TRANSACTIONS

OF THE

PHILOSOPHICAL SOCIETIES

OF ALL NATIONS, &c. &c.

VOL. XVI.

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1802.

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SIXTEENTH VOLUME.

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REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XCI.

Printed by NICHOLS and SON, Red-Lion-Paffage, Fleet-Street, London.

I. *Specification of the Patent granted to* THOMAS WAKEFIELD, *of Northwich, in the County of Chefter, Efquire; for a new Art or Method of refining Sugar.* Dated June 2, 1801.

TO all to whom thefe prefents fhall come, &c. Now KNOW YE, that in compliance with the faid provifo, I the faid Thomas Wakefield, do hereby defcribe and afcertain the nature of my faid invention, and the manner in which the fame is to be performed, as follows; that is to fay: Preffure is to be applied to the fugar intended to be refined, which may be done by weight, or by rollers, or by the fcrew or wedge, with the help of a fteam-engine, or any engine, mill, or power capable of acting, by way of preffure, with great force. The fugar fo to be refined is to be placed in fuch a fituation as to be conveniently acted upon by the preffure to be applied, and is to be contained or inclofed in a cloth, felt, veffel, or covering, either having pores or holes therein, or

 otherwife

otherwise so constructed that moisture may be discharged from the sugar through, or out of, the cloth, vessel, or covering; and to such sugar, previously containing moisture in it, or having moisture added or given to the substance thereof, or by such moisture being communicated to the inclosing cloth, felt, or vessel, or other covering, the pressure is to be applied forcibly, so as to make the moisture, or a part thereof, pass from the sugar, and out of, or through, the said covering. And thus a part of the colouring matter, and of the impurities of the sugar, will be expelled; and the degree of refinement procured will be proportioned to the quantity of pressure applied, and the quantity of moisture expelled or squeezed out of the sugar. From the moisture or substance thus forced out, there may be extracted some sugar, melasses, and rum, or other spirits, by the usual processes. And every sort of sugar, from the lowest to the highest degree in quality and value, will be very much accelerated in the refinement thereof, in several stages of the progress towards refinement, by pressure applied in the manner above described; the pressure being used as often as the workman shall think fit, according to the previous quality and state of the sugar, and the nature of the operations that are to follow. And further, the sugar refined as aforesaid may be further or otherwise refined and manufactured by the methods now in use, or by other means. In witness whereof, &c.

II. *Specification of the Patent granted to Mr.* BENJAMIN BATLEY, *of Streatham, in the County of Surrey, Merchant; for a new and improved Method of curing and preſerving all Fiſh.*

Dated January 20, 1801.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid Benjamin Batley, in compliance with the ſaid proviſo, do hereby deſcribe and aſcertain the nature of my ſaid invention to be (as is herein before ſet forth) a new and improved method of curing and preſerving all fiſh. And I farther declare, the operation to be performed in manner following; that is to ſay: After ſevering the heads, and taking out the entrails of the general kinds of fiſh, ſalt the body with bay, or rock, or common ſalt, in the caſk, in the uſual way; but the bay or rock ſalt is preferable, as the other is apt to abſorb the pickle. In the next place, pack the fiſh cloſe in the caſk, and ſprinkle ſalt between the different layers, with pickle ſufficient to moiſten the ſame. Such pickle to be made of two pounds of bay ſalt, with from eight to twelve ounces of ſaltpetre, and from four to eight pounds of melaſſes, to ſuit different palates, to be mixed in a gallon of ſpring-water, if to be be procured, and boil the ſame till the whole of the ingredients are diſſolved: river-water may anſwer the purpoſe, but ſpring water is preferable. Then let the caſks be properly headed up, and coopered, with a cork-hole either in the centre or head of the caſk, through which may be poured a farther ſupply of pickle, for the preſervation of the fiſh. The ſame proportion

of any sugar might be used as a substitute for the melasses, but the extra price probably would be considered as an impediment; and from two to three months should be allowed after curing in order to give the fish a full flavour. And with respect to shell fish, particularly oysters, when taken from the shells, they may be preserved either in kegs or barrels, with the same kind of pickle; and if requisite add one or two pounds of salt in addition to the pickle, as it may not be found expedient to put salt to them in the barrel. And for the preservation of the roes of fish by themselves, the same pickle, with a small portion of salt and sugar, or melasses mixed with the salt, will suffice. And the pickle, with the usual proportion of salt, will answer for the flavouring of every kind of fish, and they may be cured together with their heads and roes; but, on account of the oil and filth which the heads and roes contain, it is preferable to sever the heads, and take out the entrails, as the only effectual means of eradicating the noxious qualities which would otherwise adhere to them. In witness whereof, &c.

The patentee wishes to inform the public, that he has received several letters from merchants in the West Indies, and other places, giving very satisfactory accounts of cargoes cured according to the above specification; which letters he is anxious to shew to any person who wishes for information on the subject. He is also willing to grant licences under his patent, or to sell shares of it, to a few individuals, who may be desirous of curing fish agreeably to it.

III. *Specification of the Patent granted to Mr.* ANTHONY BOWDEN, *of Mellor, in the Parish of Glossop, in the County of Derby, Cotton Carder and Rover; for a new Engine or Machine for batting or beating and cleaning Cotton.*

Dated July 1, 1801.

WITH A PLATE.

TO all to whom these presents shall come, &c. Now KNOW YE, that I the said Anthony Bowden, in compliance with the said proviso, do hereby describe and ascertain the nature of my said invention, and declare that the plan thereof, drawn and contained on the paper-schedule to these presents annexed, is composed of the following particulars; that is to say: Fig. 1, (see Plate I.) a perspective view of the whole machine. A A A A, the frame of the machine. B, the flake, made of cords, upon which the cotton is batted, moving perpetually over the rollers *c*, C, which are moved by a pinion on the end of the axle of the cranks D, which drives a large bevel wheel, fixed on the bottom of the upright shaft E, upon the top of which is a bevel pinion, which drives a large bevel wheel upon the end of the axle of the roller C. F F, two boards, fixed to the cross frames, on each side of the flake B, to prevent the cotton from falling off, the which are notched, in order that the batting sticks may strike the cotton upon the flake B. G, a loose rod, crossing the flake close to the cords under the cotton, which, by the vibration of the cords, loosens the cotton therefrom before it falls over the

the roller C. Fig. 2, the ground plan of the machine, drawn by the scale T. D, an axle, having ten cranks, standing upon ten different squares or sides of ditto; the first and second of which are opposite, as are all the rest, upon different squares, alternately, to the end, with a support in the middle, with a brass step, for the axle to move in, to keep the same from vibrating. Fig. 3, a plan of four of the arms, shewing their different movements, drawn by the scale U. H, H, H, H, the arms, fixed to the bottom cross frame by an axle working in iron slides which are moveable, if necessary, at *a a*. I, I, rails, worked by two opposite cranks at *c*, *c*, and fixed to the lower ends of the arms by swivel pins at *i*, *i*. J, J, iron slides, fixed by screws to the ends of the rails I, I, in order to lengthen or contract them, as may be found necessary. K, K, rails fixed to the upper parts of the arms at *b*, *b*, by swivel pins, which work the opposite arms at *d*, *d*. L, L, L, L, wood rollers upon the tops of the arms, moving an axle in iron frames, to which axles are fixed the sockets *e*, *e*, *e*, *e*, which hold the batting sticks fastened therein by hoops and screws. M, M, M, M, leather straps fixed to the rollers L, L, L, L, and to the upper cross frame at *k k k*, as in Fig. 1; which straps, when drawn tight by the arms moving forwards towards the flake B, as in Fig. 1, strike the blows upon the cotton. N, N, two catches or hooks, which are drawn by the springs *l*, *l*, that fall into square holes, made for the purpose into iron hoops, on the ends of the rollers L, L, to prevent the sticks from rising after the blow is struck before the sticks are clearly drawn out of the cotton by the return of the arms. O, O, iron slides, fastened

by

by ſcrews to one ſide of the ends of the rails K, K, with ſtuds fixed thereto, on which the bottom part of the catches move; which ſtuds, when placed at a proper diſtance from the ſwivel pins, draw down the catches gradually as the arms move backwards, and prevent the ſticks from riſing, which they would naturally do, notwithſtanding the catches, owing to the circular motions of the arms. P, a long ſpring, with a ſmall leather ſtrap faſtened to the top part of the roller L, on the top of the arm, which throws back the ſtick on to a bolſter put on the upper croſs frame as at *f*, in Fig. 1. Q, a ſneck or catch faſtened on the end of the upper rail K, which frees the catch *g* from the roller when the arm returns to the back croſs frame, as at L, Fig. 3. R, R, two ſticks, which ſtrike upon the cotton at the ſame time, as do all the reſt in their turns, as the cranks move round. W, a ſmall ſcrew, in the bottom of the ſneck or catch Q, which binds on the top of the ſlide O, to be altered as may be neceſſary, to keep ſuch ſlide in its proper place. X, X, two ſcrews, moveable in two nuts, fixed in the ends of the croſs frames on each ſide the flake B, as in Fig. 2, by means of which the cords of the flake may be ſtraightened or ſlackened, as may be neceſſary. S, a pulley, fixed upon the end of the axle of the cranks at *h*, in Fig. 2, by which the whole of the machine is moved. In witneſs whereof, &c.

Observations by the Patentee.

Though many attempts have been made, no operation has been found out to clear the cotton, to

to expand its fibres, and bring it into that open and pulpy state essential to good carding, save batting, which is a laborious employment, and having been chiefly confined to females, who are inadequate to the task, the work has been very imperfectly performed; besides the disagreeable necessity of either confining a great number of them in a room for that purpose, or of sending the cotton out to as many different houses—circumstances which have long occasioned the trade to lament the want of some invention to remove them, and which I flatter myself is accomplished by the above described batting machine.

In a department, hitherto confessedly the most perplexing of any attending the business of cotton spinning, a very considerable abridgment of labour is effected, in so much, that, at most, two-thirds of the number of *girls* will now do the same quantity of work, and much better, than was done before by the strongest *women*.

I delayed, for some time, sending my specification to be laid before the public, in order more fully to ascertain the merits of the machine, which I have now the pleasure to state, after a variety of experiments, highly gratifying to myself, and those friends who have witnessed them, I can with confidence offer to the trade as an invention worthy its patronage.

Orders may be addressed to the Patentees, A, Bowden, and Co. No. 45, Leigh-street, Manchester, at Stockport, or at Mellor, near Stockport.

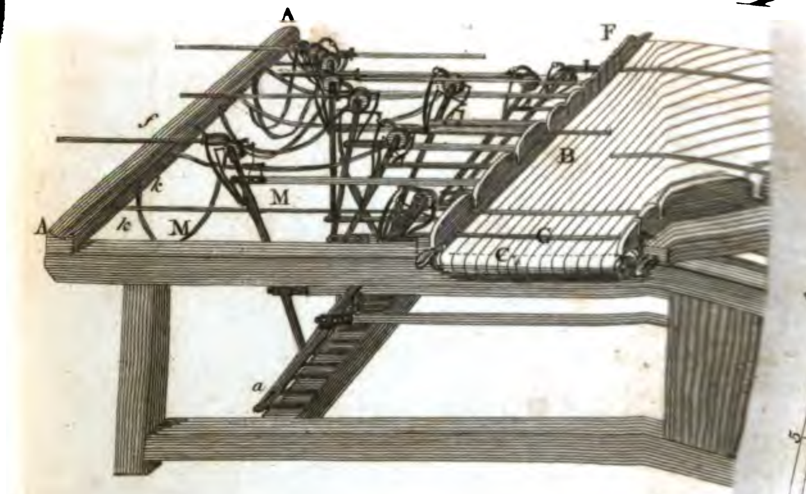
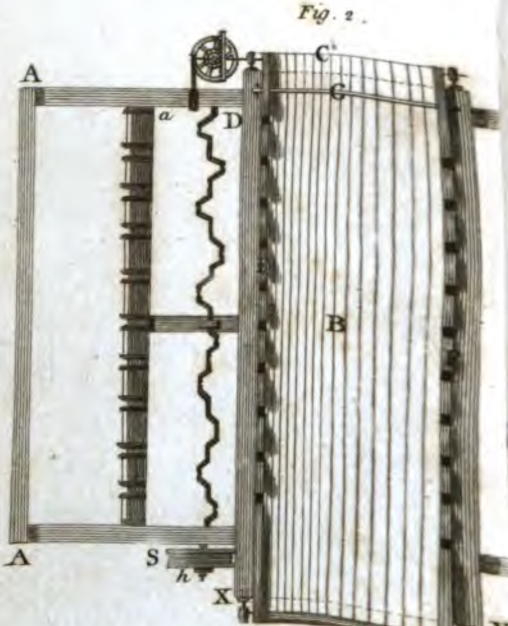
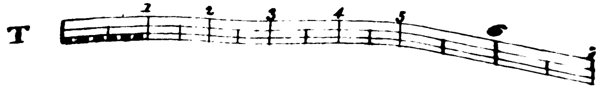


Fig. 2.





IV. *Specification of the Patent granted to* Ann Young, *of St. James's Square, in the City of Edinburgh, for an Apparatus consisting of an oblong square Box, which, when opened, presents two Faces or Tables; and of various Dice, Pins, Counters, &c. contained within the same, by Means of which six different Games may be played, which, besides being amusing and interesting, and such as Children of Eight Years old may be taught to play, are at the same Time an improving Exercise upon, and serve to render familiar, and to impress upon the Memory, the fundamental Principles of Music, particularly all the Keys or Modulations, major and minor, both with the common and uncommon Signatures, musical Interests, Chords, Discords, with their Revolutions, and the most useful Rules of thorough Bass.*

Dated March 16, 1801.

TO all to whom these presents shall come, &c. Now know ye, that in compliance with the said in part recited clause or proviso in the said letters patent contained, she the said Ann Young, by Benjamin Nind, her attorney, duly authorized, by letter of attorney, in that behalf, doth hereby declare, that the said new invention of an apparatus consisting of an oblong square box, which when opened, presents two faces or tables; and of various dice, pins, counters, &c. contained within the same, by means of which six different games may be played, which, besides being amusing and interesting, and such as children at eight years old may be taught to play,

 are

are at the ſame time an improving exerciſe upon, and ſerve to render familiar, and to impreſs upon the memory, the fundamental principles of muſic, particularly all the keys or modulations, major and minor, both with the common and uncommon ſignatures, muſical intervals, chords, diſcords, with their revolutions, and the moſt uſeful rules of thorough baſs, is deſcribed in the manner following, that is to ſay: the box is compoſed of two equal pieces or frames of cabinet-work, united by hinges like backgammon tables. When it is opened, or ſpread out, the two pieces exhibit different faces. The one preſents at each end two muſical ſtaves or ſyſtems of five lines. In each line and ſpace of theſe ſtaves, a number of ſmall holes are drilled, in which are occaſionally ſtuck the pieces of turned ivory and wood, which are deſigned to repreſent the ſharps and flats, that ſeverally belong to the different keys or modulations of muſic. Under each of theſe ſtaves there is a drawer, in one of which are contained the dice, pins, &c. which are uſed in playing with ſharps; and, in the other, the correſponding dice, pins, &c. uſed in playing with flats. Theſe drawers are pulled out from the ends of the frame, and, when in their places, are kept firm by braſs pins running through the edge. In the middle ſpace betwixt them are contained two dice boxes; when theſe are taken out and the game is to be played, this vacant ſpace is covered by a moveable lid, which at other times reſts upon one of the ends. The ſurface of the table is by that means rendered compleat and uniform. Upon the outer part of the border round it are written the fundamental letters of all the 12 major keys, according to the order of ſucceſſion by

flats;

flats; and, immediately below or within each of thefe, the fundamentals of their relative minor keys. At each letter there is a fmall hole for receiving a pin. The other face or table is of one piece. At each end is a delineation of the clavier or finger touches of a piano forte, in every one of which there is a fmall hole. Above thefe are two mufical ftaves, on which are written in crotchets the whole fcale of natural notes. In the round head of each crotchet, there is a fmall hole, for receiving pins or moveable notes; and alfo immediately below each of them, there is another fmall hole for receiving the pins, on the heads of which are the characters of fharp, double fharp, flat, double flat, and natural. Around this table there is a border fimilar to that which furrounds the other table, on which are marked the fundamental letters of the 12 major keys, according to the order of fucceffion by fharps, with their relative minors below or within each. In the drawer which contains the apparatus for fharps, there is at one end in front a fquare compartment, in which is an uncovered box or moveable frame, divided by a partition in the middle into two cells, in one of which are contained 14 pieces of turned ivory, and in the other, 10 fuch pieces of a different fhape, the former intended to reprefent fingle fharps, and the latter to reprefent double fharps, and defigned to be ftuck into the holes in the lines and fpaces of the ftaves upon the table firft defcribed, for the purpofe of exhibiting the fignatures of all the keys of mufic with fharps. Behind this compartment are two fmall fquare cells, in each of which is a cylindrical box, the one containing 12 larger, and the other 12 fmaller ivory counters. The remaining part

of the front of the drawer is a range, divided into four ſmall ſquare compartments, marked 1, 2, 3, 4, in each of which are four dice, and a ſmaller one at the end, marked 5, in which lie two ivory pins. The firſt pair of dice in the compartment 1, have upon their faces, the one, the capital letters G, D, A, E, B, F* being the fundamentals of ſix major keys with ſignatures in ſharps; the other, the ſmall letters e, b, f*, c*, g*, d*, being the fundamentals of ſix relative minor keys with ſignatures in ſharps. The ſecond pair in the compartment 1 have upon their faces, the one, the capitals C*, G*, D*, A*, E*, B*, being the fundamentals of the ſix remaining major keys, with uncommon ſignatures, or according to the order by ſharps continued from ſix to twelve; the other, the ſmall letters a*, e*, b*, fX, cX, gX, the fundamentals of the ſix remaining minor keys with uncommon ſignatures. The four dice in the compartment 2, have each upon their faces reſpectively in order the very ſame fundamentals of the keys major and minor with the former, repreſented in muſical notes baſs ſtaves, with the ſignatures proper to each. In the compartment 3, there is 1ſt, a die having upon its faces C, the ſame note on a muſical ſtave, A, the ſame note on a muſical ſtave, and two baſs ſtaves without ſignatures; 2dly, a die having on its faces baſs ſtaves, with ſignatures of 1, 2, 3, 4, 5 and 6 ſharps, but without any notes; 3dly, a die having upon three of its faces the letter T, and upon the other three the letter S; 4thly, a die having upon its faces the characters of treble, baſs, and tenor cliffs. In the 4th compartment are dice with various numeral figures. The ſpace behind this range is divided into two com-

compartments. In one of theſe, upon a raiſed ſurface, are ſtuck 14 ivory pins, with ſmall flat heads, on ſeven of which are marked the muſical character ✱, or ſharp, on five the character X or double ſharp, and on two, the character ♮ or natural. Upon the ſunk ſurface beſide theſe are ſtuck three ivory plates, bearing the marks of the treble, tenor and baſs cliffs. In the other compartment are ſtuck 8 black, and two white pins, with ſmall round heads, which are uſed as muſical notes. The other drawer, which contains the apparatus for flats, is, in its diviſions and compartments, exactly ſimilar to the one now deſcribed. The 14 and the 10 pieces of turned work contained in the divided box, or moveable compartment, which repreſent ſingle and double flats, are exactly of the ſame form with thoſe for ſharps, but for the ſake of diſtinction are made of dark-coloured wood. The counters are of ivory ſtained red. The 1ſt pair of dice in the compartment 1, have, the one, the capitals F, B♭, E♭, A♭, D♭, G♭, the fundamentals of ſix major keys, according to the order by flats; and the other, the ſmall letters d, g, c, f, b♭, e♭, the fundamentals of the reſpective minor keys. The 2d pair have, the one, C♭, F♭, B♭♭, E♭♭, A♭♭, D♭♭, the fundamentals of the other ſix keys with uncommon ſignatures, or according to the order by flats continued up to 12; the other, a♭, d♭, g♭, c♭, f♭, b♭♭, their reſpective minors. The four dice in the compartment 2, have the very ſame fundamentals, repreſented in muſical notes upon baſs ſtaves, with their proper ſignatures. In the compartment 3, there is, 1ſt, a die having baſs ſtaves with the ſignatures of one, two, three, four, five and ſix flats, but without notes;

notes; 2dly, a die having upon its faces one line, one line and a half, 2 lines, 2 lines and a half, 3 and 4 lines: 3dly and 4thly, a pair, having upon their faces various thorough bafs cyphers, and chords upon mufical ftaves. In the compartment 4, there is, 1ft, a die having upon one of its faces the character ♮, upon two, the character *, and upon the other three, numeral figures; 2dly, a die having upon one of its faces the character ♮, upon two, the character ♭, and upon the remaining three, numeral figures. Laftly, a pair bearing upon their faces the fundamental letters of all the keys major and minor of the firft circular fyftem.

GAME I. *Circular Syftems.* The object of the firft game or exercife is to imprefs upon the memory, and to render eafy and familiar, the fignatures of all the major and minor keys of mufic. To facilitate this exercife to thofe who may not have been fully inftructed in this branch of mufical knowledge, two circular fyftems are given. In each of thefe, the fignatures and the fundamental notes of the twelve major keys are written in mufical characters upon the outer ftave, with the correfponding letters below them; and the fignatures and fundamentals of the twelve minor keys are written in a fimilar manner upon the inner ftave. In the firft fyftem, beginning at No. 1, or major key of C, without fharp or flat, and proceeding along the outer ftave, towards the right hand, the major keys fucceed each other according to the order of fucceffion by 5ths: in other words, the fundamental of each key or fcale is always the 5th of that immediately preceding. In this fucceffion one fharp is gained, or one flat is dropped at every ftep. The 7th key is that of F*

F* with ſix ſharps. The ſcale of this key is played upon the inſtrument by touching the very ſame finger keys with that of G^{b} with ſix flats. From this the ſucceſſion by 5ths is continued with ſignatures of flats, one flat being dropped at each ſtep, till it comes round to C. Again, beginning at No. 1, and proceeding along the outer ſtave towards the left hand, the major keys ſucceed each other according to the order of ſucceſſion by 4ths; the fundamental of each key or ſcale being always the 4th of that immediately preceding. In this ſucceſſion one flat is gained, or one ſharp is dropped at every ſtep. As the ſucceſſion by 5ths is that by which regular muſic moſt frequently proceeds, and as it is generally the firſt that is taught, the keys are numbered from 1 to 12, according to that order. In the inner ſtave, beginning at No. 1, the minor key of natural notes, the fundamental of which is A, and proceeding towards the right hand, the ſeveral minor ſcales ſucceed each other alſo according to the order of ſucceſſion by 5ths, one ſharp being added, or one flat thrown off, at every ſtep; and proceeding towards the left land, they ſucceed each other according to the order by 4ths, one flat being added, or one ſharp being thrown off at every ſtep. By this arrangement, all the major keys, and their *relative* minor keys, (thoſe namely which have the ſame ſignature,) are found in the ſame diviſion of the ſcheme, or betwixt the ſame rays of the circles. In carrying on the ſucceſſion of keys towards the one hand by 5ths, and towards the other hand by 4ths, the ſignatures of flats and of ſharps may be continued beyond the number ſix. Keys or ſignatures of more than ſix ſharps or flats, appear

in

in the works of the most eminent composers, particularly in the progress of modulation, through an extended piece of music; and double sharps and double flats, which necessarily result from such numerous signatures, frequently occur. To render these signatures familiar, and to remove the embarrassment which they occasion to young performers, the exercise of the game is, in its 2d part, extended to them; and with that view is given the 2d Circular System, intituled, "With uncommon signatures." In this system, setting out from the keys No. 7, which must obviously be the same in both systems, and proceeding towards the right hand, the succession by 5ths is carried on in signatures of sharps; and from the same point proceeding towards the left hand, the succession by 4ths is continued in signatures of flats; the number of each gradually increasing from six to twelve, where they meet in the key No. 1. In reckoning the numbers of these signatures, every double sharp and every double flat is accounted two. The several keys of this system are, respectively, the very same upon the instrument with those in the 1st system, which appear under the same numbers. A piece of music, written in the major key of F*, or minor of D*, with six sharps, will be played by the same finger touches, as if it had been written in the major of G^b, or minor of E^b, with six flats. Six sharps and six flats are therefore corresponding signatures. In the same manner, 7 sharps and 5 flats—8 sharps and 4 flats—9 sharps and 3 flats—10 sharps and 2 flats—11 sharps and 1 flat—12 sharps and nothing:—as also 7 flats and 5 sharps—8 flats and 4 sharps—9 flats and 3 sharps—10 flats and 2 sharps—11 flats and 1 sharp—12 flats and

and nothing, are corresponding signatures. In order that all the keys, with the numbers of both signatures, may appear distinctly at one view, two small circular systems are exhibited, in one of which all the major keys are shewn in both denominations, and in the other all the minor keys. It thus appears, that a piece of music, the key-note of which, *upon the instrument*, is any one of the twelve finger touches, comprehended within the octave, may be written either with a signature of sharps, or with a signature of flats—that the number of the sharps in the one signature, and of the flats in the other signature, when added together always amount to 12; and therefore that when the number of the one species is deducted from 12, the remainder will give the number of the other species. It farther appears from the schemes, that the fundamental of the signature in flats is always one letter advanced in the musical alphabet, or one degree higher in the stave, than the fundamental of the corresponding signature in sharps. As for the sake of simplicity and ease, the signature of the smallest number, whether of sharps or of flats, is commonly preferred, signatures of more than six may be called *uncommon signatures.* In tracing the signatures of the several keys, according to the order by 5ths, through the two schemes from the natural key upwards, it will be found, that the sharps enter the system upon the following notes in order, *viz.* F, C, G, D, A, E, B, and that the double sharps enter upon the same notes, and in the same order. Again, in tracing the signatures according to the order by 4ths, it will be found that the flats and the double flats enter the system upon the following notes in order, *viz.* B, E, A, D,

G, C, F, or that the order of flats is exactly the order of sharps reversed. By comparing the two systems it appears, that when any fundamental is sharpened or raised a semi-tone, the number of sharps in its signature is increased by seven; and that when any fundamental letter is flattened or lowered a semi-tone, the number of flats in its signature is also increased by seven. Thus the major key of C has no signature; that of C* has 7 sharps; the major of D, 2 sharps, that of D*, 2 and 7 or 9 sharps; the minor of F* has three sharps, that of F** has 3 and 7 or 10 sharps. Again the major of C^b has 7 flats; the major of B^b has 2 flats, that of B^{bb} has 2 and 7 or 9 flats, &c. As all additional sharps or flats, above seven, are obtained by doubling those which are first in order, it follows that the number and places of the *double* sharps or *double* flats, in the signature of any key letter in the 2d system, will be the same with the number and places of the *single* sharps or *single* flats, belonging to the same letter in the 1st system.

GAME I. Part 1st. To play this game there must be taken from the two drawers; 1st, The pairs of dice No. 1, in the 1st compartment; 2dly, The moveable compartments, containing the pins, which represent sharps and flats; 3dly, The ivory plates bearing the characters of the treble and bass cliffs; 4thly, The boxes containing the twelve large counters. Each player then throws one die; and whoever turns up the key with the greatest number of sharps or flats plays first, and has the choice of playing with sharps or flats. The cliffs being properly placed upon the great staves, the first player takes his pair of dice (of which that marked with capital letters bears the funda-

fundamentals of the major, and that with ſmall letters, the fundamentals of the minor keys,) and having thrown them, muſt firſt tell the number of ſharps or flats belonging to the keys which are turned up: he muſt then arrange thoſe ſharps or flats upon the ſtaves, on his ſide of the board, by placing the pins in the holes which are made for that purpoſe, naming them, and ſetting them up, in the exact order in which they enter the muſical ſyſtem, or in which they are arranged upon the circle. The ſignatures of the major keys may be arranged upon the treble ſtaves, and thoſe of the minor keys upon the baſs ſtaves; or this, at the pleaſure of the players, may be occaſionally reverſed. It is hardly neceſſary to remark, that when the ſignatures are to be arranged upon treble ſtaves, the characters of ſharp and flat muſt be reſpectively placed one line or one ſpace higher, than when they are arranged upon baſs ſtaves, upon which they appear in the circles. The ſecond player next throws, names, and arranges the ſignatures of the keys which he has turned up, in the ſame manner. They then count the number of flats or ſharps which each has ſet up, and for every three which the one player has more than the other, he gains a point of the game, which is to be marked by putting up a counter. This comparative reckoning is to be repeated after each throw of the ſecond player, ſo long as the game laſts.

ADVANTAGEOUS CHANCES. Relatives. When the dice turn up a major key and its minor relative, that is, when the major and the minor preſented have the ſame ſignature, the player who obtained the throw is entitled to 2 points to be marked by putting up 2 counters. Pairs. When

both dice present the ſame letter, as E e, F f, that is, when the keys turned up are major and minor of the ſame fundamental, the thrower is alſo entitled to 2 points. Sequences. When the two letters preſented are next to each other in the order of the muſical alphabet, as B, c, g, A, &c. 1 point. Counterparts. When either of the players obtains a throw which gives the ſame numbers upon each of his ſtaves reſpectively, as are already arranged upon thoſe of the adverſary. A counterpart of ſixes upon each ſtave, 6 points. A counterpart of threes upon each ſtave, 3 points. Every other counterpart, 2 points.

Disadvantageous Chances. When either of the dice turns up the ſame key, which had been preſented at the laſt preceding throw, and which therefore is already arranged upon the ſtave, the ſharps or flats upon that ſtave muſt all be taken off, and of courſe cannot be counted at the comparative reckoning. Falſe Pairs. When the ſame letter is preſented by the two dice; but the one has the character of ſharp or flat annexed to it, and the other has not, as D d*, g G♭, the adverſary is entitled to one point. Croſs Counterparts. When, upon the ſharps or flats indicated by a throw being ſet up, the number upon the treble ſtave is the ſame with that upon the adverſary's baſs ſtave, and the number upon the baſs ſtave is the ſame with that upon the adverſary's treble ſtave, the adverſary is entitled to 1 point. Forfeitures. If either of the players, from ignorance or inadvertency, makes a miſtake in naming and ſetting up the ſharps or flats of the keys preſented by his dice, the adverſary, if he can correct the miſtake, is entitled to 1 point. When relatives, pairs or ſequences are thrown, the

the player who has obtained the throw must mark the points of the game to which it entitles him, before he begins to arrange the sharps or flats, otherwise he forfeits the advantage, and to this advantage the adversary is entitled, if he points out the omission before throwing his dice. When false pairs are thrown, or cross counterparts are set up, the adversary must mark the advantage to which he is entitled, before he proceed to throw his dice, otherwise he forfeits the advantage. The player who first gains 12 points, or puts up all his twelve counters, wins the game.

PART 2d. This is intended to afford the same exercise upon the signatures of the 2d system, which the first part gives upon those of the first system. In playing it, the pairs of dice, No. 2, in 1st compartment are to be used. The sharps or flats, double and single, which belong to the keys that are turned up, are to be numbered and named, and the pins representing them are to be arranged upon the staves, agreeably to the 2d circular system; the pins with coloured heads being employed to represent the double sharps and double flats, and the others, as in the first part, to represent the single. A counterpart of sevens entitles the thrower to 7 points. A counterpart of twelves, to 12 points. In all other respects this part is played in the same manner as the 1st part. Considerable assistance in playing this game will be obtained by attending to the observations which are subjoined to the explanation of the circular systems.

The 2d game is an exercise upon the intervals of Music.

TABLE

TABLE OF INTERVALS.

Number of semi-tones upon the instrument from the lower note.	NAMES.	EXAMPLES.
1	Diesis or imperfect prime	C C✱ D D♭
1	Semi-tone or minor 2d	C D♭ F✱G
2	Tone or major 2d	C D
2	diminished 3d	B✱D
3	Superfluous 2d	C D✱
3	Minor 3d	C E♭ A c
4	Major 3d	C E
4	diminished 4th	B✱ E
5	PERFECT 4th	C F
6	Tritone or superfluous 4th	C F✱
6	false 5th	C G♭ B F
7	PERFECT 5th	C G
8	Superfluous 5th	C G✱
8	Minor 6th	C A♭
9	Major 6th	C A
9	diminished 7th	B✱ A G✱ F
10	Superfluous 6th	C A✱
10	Minor 7th	C B♭
11	Major 7th	C B
11	diminished 8ve	C c♭
12	PERFECT 8ve	C c
13	Superfluous 8ve	C c✱

Of these intervals, the perfect 4th, perfect 5th, and perfect 8ve, as also the major and minor 3ds, and the major and minor 6ths, are concordant: all the rest are discordant.

GAME II. Part 1st.—*Intervals upon the Clavier or Key board.*—This game is played by means of the pairs of dice No. 3, in 2d compartment, or those with common signatures, the one player taking the pair with sharps, and the other the pair

pair with flats. The first throw, and the choice of playing with sharps or with flats, are determined by throwing single dies. The person who plays with sharps places one of the pins which are found in 5th compartment, upon the key A, of the double bass octave or third long key, and his object is to ascend to the highest. The other player places one of his pins upon the highest key F, and his object is to get down to the lowest. The player who first attains his object wins the game. When the dice are thrown, the player, by attending to the signatures and the notes which they present, and by comparing them together, must tell the names of the two keys, and which of them is major and which minor. He must also tell the exact musical interval betwixt them, and whether that interval be concordant or discordant. If then the interval is concordant, he moves his pin the exact extent of it, *forward*, or according to the proper direction of his game; if it is discordant, he moves his pin the extent of it *backwards*, or in the contrary direction. If a discordant interval cast up at the beginning of the game before any movement has been made, the throw is lost. If the station of the player be not sufficiently advanced, to allow a discordant interval to be taken backwards its whole extent, he returns to his original station.

Relatives. When the signatures are the same, that is, when the keys presented are major and minor relative, the pin is first to be advanced, the concordant interval presented, and afterwards a perfect 5th in addition.

Pairs. When the dice present a pair, that is, when the notes are unison, or perfect primes, the

the pin is to be carried forward an octave. Before moving, the thrower must call upon the adversary to give the unison, which he must do by placing a pin in the same key of his clavier, in which the pin of the thrower stands; at the same time telling its name, and the particular octave of the instrument, in which it is*. If the adversary performs this without mistake, he gains a major 3d, or is entitled to take that interval forward upon his clavier. If he fails or makes any mistake, he must go backwards a 5th. When the dice present a false pair, or the notes are imperfect primes, the thrower, before he move backward the discordant interval or semitone, must give a similar challenge to the adversary, who must place a pin in the key which is imperfect prime to that in which the pin of the thrower stands, at the same time telling the names of both, and the particular octave of the instrument, in which they are. If he executes this accurately, he gains a 5th; if he fails, he must go back a major 3d.

Coincidences. When the interval to be moved upon the clavier happens to be the same, not only in extent but in the names of its two terms, with that presented by the dice; in other words, when the pin is upon a key of the same name with the note presented by one of the dice, and proceeding forward or backward according to the rules of the game, it is to be carried to a key of the same name with the note presented by the other;

* The several octaves of the instrument, or of the great scale of music proceeding upwards from F to F, may be thus named in order, Double bass octave—Bass 8ve—Tenor 8ve—Treble 8ve—High Treble 8ve.

other; the thrower, after having moved his interval, is entitled to advance an octave.

FORFEITURES. If a player, upon throwing his dice, shall make a mistake in reporting the signatures, keys, and interval presented by them, and shall have taken hold of his pin, for the purpose of moving it, or marking the interval; and if the mistake shall be challenged by the adversary, he shall forfeit any advantage which he might have gained by the throw. If again a player, in performing his interval, shall place his pin upon a wrong key, or that is not distant from the former station the exact extent of the interval presented by the dice, and shall have withdrawn his hand from it, if the interval was concordant, he shall lose the advantage of the throw, or be obliged to bring back his pin to the former station; if the interval was discordant, he shall be obliged to carry back his pin a major 3d, beyond the exact extent of it. The adversary must challenge such mistakes before he throw his dice, otherwise he loses the privilege. To prevent disputes which may arise upon occasion of these challenges, and in order that the interval taken may be distinctly perceived, it may be adviseable, through the whole course of the game, to employ two pins, and instead of moving the pin which is at the station, to keep it in its place, and to mark the interval presented by the dice, by the other pin. In this way, both terms of the interval will appear upon the board at the same time. The pin which was last set up, if no objection is made, becomes the station pin of the game; the other must remain in its place till the adversary has thrown, when it should be immediately

 removed,

removed, for the purpose of marking the interval, which shall be next presented.

Game II. Part 2d.—*Intervals upon the Stave.*—This part affords the same exercise upon the musical stave or scale of notes, which the former part gives upon the clavier. When it is played it will be proper that the claviers be covered. The player with sharps places in the double bass A, one of the moveable notes or small pins with round heads, found in 9th compartment, and his object, as before, is to ascend to the highest note; the other places a note in the highest F, and his object is to get down to the lowest. The intervals of the same extent with those presented by the dice, are to be marked by carrying the pin along the scale of notes; or rather, by placing another pin of the same kind, in the note which is the other term of the interval; annexing or placing in the hole under the note the moveable characters of sharp, double sharp, flat, double flat, according as these may be necessary for exhibiting the exact intervals. If, when the station note is affected with double sharp or double flat, an interval should cast up, to represent which, truly, would require an additional sharp or flat, the player is then allowed to change the denomination, and of course the place of the station note, to that which would be founded by the same key of the clavier. Thus if the station note being D**, a major 3d should be presented, which must be F***; the note D**, may be changed to the corresponding note upon the clavier, E natural, when the major 3d will be G*. As the player with sharps is understood to have the custody of the characters of sharp and double sharp, and the player with flats to have the custody

tody of thofe of flat and double flat, if either of them, in the courfe of the game, find it neceffary, for truly exhibiting his interval, to employ a character of the oppofite fpecies, he muft borrow it of the adverfary, who in confideration of having given him this accommodation is entitled to advance a major 3d. He is allowed to retain the borrowed character fo long as it is neceffary for reprefenting his interval, without the lender being entitled to any additional advantage. But fo foon as he throws an interval for which that character is not neceffary, he muft return it to the adverfary. In all other refpects the method of playing the advantageous chances and the forfeitures in this part of the game, are the fame as they are in the 1ft part.

GAME III. *Of Cadences or Preludes.* The natural prelude to any key of mufic confifts of the following chords in order, viz. chord of key—of 4th—of 5th and of key; the proper difcording notes being added to the chords of 4th and of 5th. The chord of the 4th always follows the mode of the key; that is, its 3d muft be major or minor, according as the 3d of the chord of key is major or minor. The chord of the 5th muft, in every cafe, have its 3d major. To practife thefe preludes in the way of game, the perfon who plays firft throws his pair of dice No. 3, or thofe bearing upon ftaves, the fundamentals and fignatures of the firft circle; and has the choice of either of the notes prefented for the key note of his prelude. He then fets up the common chord of that note upon his clavier, by placing his moveable notes in the proper keys, and employing a white one for his bafs note,—taking particular care, that the 3d of his chord be major or minor, according

as the key note which he had chosen was a fundamental of the major or minor mode.—The other player does the same. The first player then puts into his box the die of the same mode, (major or minor,) with his key, and also the die of signatures without notes *. If upon throwing, either the 4th to his key note is presented by the one die, or the signature of that fundamental note, according to the required mode is presented by the other die, he sets up the chord of his 4th, with its 6th added. If neither of these are presented, he marks his disappointment by putting up a counter, which he also does at each of the two next throws which he makes in his turn, if neither of the faces wanted are cast up. After that, he is allowed, by way of help, along with his two dies, to put also into his box one of his letter dies No. 1, that namely, which bears the fundamentals of the mode required: and he is to continue to throw in his turn, until he obtain his 4th either in letter, note, or signature. He then proceeds to throw for his 5th. If his prelude is in the major mode, he uses the same two dies, which he used for his 4th. If his prelude is in the minor mode, in place of his die of fundamentals and signatures, he must take the die of *major* fundamentals and signatures, which has the note wanted, borrowing it, if necessary, from the adversary. If the note or signature wanted do not occur in *three* successive throws in turn, to be marked as before by counters, he is allowed a

* This die is intended as a farther exercise upon fundamentals and signatures; and whenever it is thrown, the player must name the fundamental note, both of the major and minor key, which has the signature presented.

similar

ſimilar help to what was allowed for the chord of 4th, that is, to join with his two dies the die of major fundamental letters, which has upon one of its faces the letter wanted. When he obtains his fundamental, he muſt ſet up his chord of dominant, or chord of the 5th to his key with its 7th added, making the ſeveral notes of his chord of 4th proceed into it, according to the rules of muſic. Laſtly, to get home, he throws for his key note, uſing at firſt only his die of notes and ſignatures; and if he does not ſucceed in *three* throws, taking for help a letter die, as before. When he obtains it, he ſets up the chord of his key, or makes the ſeveral notes of his chord of 5th paſs into it according to rule. His firſt prelude is then completed. The player next proceeds to perform his ſecond prelude, which muſt be in the minor mode, if the former was in the major mode, and contrariwiſe. He determines his key note by throwing a die, and proceeds as before. When this is finiſhed, he executes his third prelude, in the mode which is directed by the adverſary. In every ſucceeding prelude, the *poſitions* of the chords, or the arrangement of their notes muſt be changed. As the natural keys, C and A, do not appear upon any of the dice in the two firſt compartments, when theſe may be wanted as the fundamentals of a chord, the player may uſe the die in the 3d compartment of the ſharp drawer, which bears upon its faces theſe keys, both in letters and in notes upon ſtaves. If a player ſhall commit an error in placing or arranging the notes of his chords, he ſhall loſe the benefit of the next advantageous throw; or ſhall be ſubjected to ſuch other penalty, or give ſuch other advantage to the adverſary, as may be previouſly

viously agreed upon by the parties. He who shall have first completed three preludes wins the game.

Part 2d. The same exercise performed upon the keys with uncommon signatures by using the dice of the second circle. When the dies of signatures without notes are to be thrown, the player with sharps may take the die of flats, and the player with flats the die of sharps; and if the signature of the *corresponding* key to that which is wanted shall be cast up, he may proceed to set up his cord.

Game IV. *Rule of the Octave.* The chords or proper accompaniments of the several notes of the bass scale, ascending and descending. These chords may be exhibited upon the claviers, by placing the moveable notes in the keys, as in the last game. The dice to be used are the four in the 4th compartment of the sharp drawer, having upon their faces numeral figures. These four dice are to be thrown by each of the players in turn; and whenever among the figures presented are those which express the intervals to the bass note of the several notes of the chord, which is to be performed—in other words, which constitute the complete thorough-bass cypher of that chord, the player may proceed to set it up. As the figures expressing *all* the intervals of a chord may frequently not appear *together*, in a considerable number of throws; if this does not take place in three successive throws in turn, (to be marked by putting up counters,) a smaller number, or even one of the intervals being *afterwards* presented, may be a sufficient warrant to the player, to proceed with his chord. This may be regulated in the following manner: when the chord to be set up

up is that of the key, the player is not entitled to take it by his first three throws, unless the numbers 3, 5 and 8, appear together. After that, if any one of them is cast up, he may proceed. When the concordant harmony or perfect chord of the 5th is wanted—for the three first throws, 3, 5—afterwards, either of them. When a concordant chord of 6th is to be played—for the three first throws 3, 6—afterwards 6. When the chord is that of 3d, 5th, and 6th, to the 4th of the ascending scale—for the three first throws 3, 5, 6—afterwards 5, 6. When the chord is that of 3d, 4th, and greater 6th, commonly called chord of greater 6th,—3d, false 5th and 6th, called chord of false 5th,—2d, tritone and 6th called chord of tritone—for the three first throws, all the figures of which they consist—afterwards, the characteristic intervals greater 6th, false fifth, tritone respectively. As the cyphers of greater 6th, false 5th, and tritone are all upon one die, it need not be thrown, unless when those intervals are wanted. The player who in this manner shall first set up in order the several chords of the ascending and of the descending scale wins the game.

Part 2d. The same exercise upon the rule of octave in the minor mode. When for proceeding correctly from the 7th to the 6th of the descending scale, the suspending 7th may be necessary for the chord of the 6th, the player is not to take that chord, for the three first throws, unless the figures 3 and 7 are cast up—afterwards, 7 may be sufficient. If, in either case, a 6th shall appear at the same time, he may immediately make his 7th pass into the 6th—if not, he must throw for a 6th. When either of these exercises is repeated, the chord of key ought to be set up in

a dif-

a different poſition, which will lead to different poſitions of the other ſucceſſive chords. The penalties or forfeitures for miſtakes, ariſing from ignorance or inadvertency, may be ſettled as in the laſt game.

GAME V. *Of the reſolution of Diſcords.* This game is played with the ſame ſets of dice as the ſecond game; and the ſame attention is to be paid to, and the ſame account to be given of the muſical intervals which are caſt up. Each of the players takes his twelve larger and twelve ſmaller counters. In reckoning the game, the 12 ſmaller counters are held to be equivalent to one of the larger; and the party is gained by the player who has firſt ſet up all his 12 large counters. When the interval preſented is concordant, the player who has obtained the throw muſt tell how many ſemi-tones the interval conſiſts of, and is entitled to put up the ſame number of ſmall counters. When the interval preſented is diſcordant, the player who has thrown it, muſt firſt ſet up the ſame interval upon the clavier, or upon the ſtave, by means of the moveable notes. He muſt then duly reſolve the diſcord, according to the rules of muſic. When in making the reſolution, only one of the terms moves, if a tone, the thrower is entitled to 6 ſmall counters; if a ſemi-tone, he is entitled to 12 ſmall or 1 large counter. If one of the terms move a ſemi-tone and the other a tone he will be entitled to 1 large and 6 ſmall counters. If both the terms move ſemi-tones, he will be entitled to 2 large counters. When a due reſolution of the diſcord may be obtained by moving one of the terms either a tone or a ſemi-tone, the player muſt determine in which of the two modes

modes he is to proceed, by throwing the die, upon which are the letters T and S.

GAME V.—PART 2d. If instead of using the pairs of dice No. 3, as in the last part, the player with sharps takes the minor die of No. 3, and the minor die of No. 4, and the player with flats takes the minor die of No. 3, and the major die of No. 4, a variety of intervals may be obtained, which do not appear in the pairs No. 3, by means of which, the exercise of the game may be extended to some of the most interesting harmonical combinations of the modern music. In order that compleat practice may be obtained upon two of these combinations that are of most frequent occurrence, viz. the chords of superfluous 6th, and that species of chords, which are sometimes called chords of substitution, or of borrowed harmony *, the two dies No. 5, in compartment 3d of the flat drawer, are provided; the one with thorough bass cyphers upon three of its faces, and staves with chords upon the other three, for the chord of superflous 6th; and the other, which has thorough bass cyphers upon all its faces but one, for the chords of substitution. As the dice used in this game may sometimes present two notes

* The chord of superfluous 6th is the accompaniment given by the modern musicians to the minor 6th of a scale, leading to a medial close upon the perfect chord of the 5th.—The chords of substitution may be considered as derived from the chord of dominant, or of the 5th of the scale accompanied with greater 3d, 5th, 7th, and 8ve, by substituting for the 8ve, the 9th to the fundamental, or 6th of the scale. The fundamental cannot exist in this chord but as the bass or lowest note. Most commonly however it is suppressed altogether; and then the several notes of the chord are the major 7th or sensible note, the 2d, the 4th, and 6th of the scale, any one of which may be inverted into the bass, except the 6th, when the mode is major, or when it is a tone above the 5th.

 which

which are incompatible, or which cannot exist together in music; as the discordant intervals, which they may at other times present, may be considered as arising from appoggiaturas, or notes of grace and expression, rather than as indicating any distinct species of chord; and as of some of the intervals which may enter into this game, the number in the sharp dice is not equal to that in the flat dice; with a view to simplify and equalise the party, the winning throws for the sharps and for the flats may be restricted to those which follow, and all the other throws which may occur may be considered as lost.

Sharps.	Flats.
1 Minor 9th	1 Superfluous 9th
1 Major 7th	1 Major 7th
1 Diminished 7th	1 Diminished 7th
2 Diminished 3ds	2 Superfluous 6ths
1 Superfluous 5th	1 Superfluous 5th viz. Bbb F
1 Diminished 4th viz. B*E	1 Diminished 4th
3 False 5ths	3 Tritones
2 Superfluous 2ds	2 Superfluous 2ds Cb D Bbb C
—	—
12	12

When a superfluous 6th is presented, the player must set up the same interval by moveable notes upon his clavier, and must tell the key note or the fundamental of the scale, in which the two notes which he has set up would be superfluous 6th, and also what degrees of that scale, the two notes are; being allowed if he chuses it, to change the denomination of the notes from sharp to flat, or from flat to corresponding sharp. He then resolves the discord according to rule, and is entitled to the several advantages stated in the first part.—After this, if required by the adversary, he must throw a die of signatures, and also the proper subsidiary die, and must set up the compleat

compleat chord of ſuperfluous 6th, belonging to the key indicated by the ſignature preſented, according to the model or the cypher caſt up by the ſubſidiary die, diſtinguiſhing his baſs note, which muſt be minor 6th of the ſcale by a white pin, and muſt then reſolve the chord, or make the ſeveral notes of it paſs properly into thoſe of the perfect chord of 5th. If he performs this correctly, he ſhall be entitled, over and above the advantage which he has obtained from the reſolution of the diſcord of ſuperfluous 6th, to ſuch other advantages, as may correſpond to the other movements, which he ſhall have made. If he make any miſtake, the adverſary, if he ſhall have challenged the miſtake before throwing, ſhall be entitled to the whole additional advantage. If the player with ſharps ſhall caſt up a diminiſhed 3d, he ſhall be allowed to invert it into a ſuperfluous 6th, and then to proceed as above. The intervals, diminiſhed 7th, ſuperfluous 2d, minor 9th and ſuperfluous 9th, are all to be conſidered in this game, as indications of chords of ſubſtitution or borrowed harmony, in the minor mode. When any of theſe is turned up, the ſame interval or one of equal extent, the adverſary being allowed to name the lower term, is to be ſet upon the clavier, it being underſtood that when the minor 9th is thrown, the player may join with theſe the major 3d or 5th, to the lower term; the declaration of the key note and of the degree of the ſcale which each note is upon, being made, the diſcord being reſolved, and the correſponding advantages being taken, as in the chord of ſuperfluous 6th. After this, upon the requiſition of the adverſary, a ſignature die and alſo the ſubſidiary die for ſubſtitution chords are to be

 thrown,

thrown, and the compleat minor ſubſtitution chord belonging to the key preſented muſt be ſet up, the poſition of the chord and the baſs note being determined by the cypher caſt up by the ſubſidiary die, and muſt be duly reſolved. The ſame additional advantages, correſponding to the movements made, accruing to the thrower, if he ſucceeds, or to the adverſary if he ſhould fail, as are above ſtated. Falſe 5ths and tritones are to be treated in this game, as indications of ſubſtitution or borrowed harmony chords in the major mode. When any of theſe are caſt up, the player muſt throw a ſignature die, and alſo the ſubſidiary die, and muſt ſet up the compleat major ſubſtitution chord for the key preſented, in its proper poſition, to the baſs note indicated by the cypher of the ſubſidiary die. If the cypher 2, 4, 6, ſhall be caſt up, the player may throw again, till he obtain ſomething elſe. When the ſtave and chord upon one of the faces of that die is preſented, the player, after having ſet up and reſolved the diſcord, which he had previouſly thrown, muſt give an account of the derivation of ſubſtitution chords, and exhibit them in their different poſitions and inverſions upon his clavier. If he performs this taſk correctly, he ſhall be entitled to an additional counter; if he fails, and the adverſary can perform it, he may claim that advantage. When a major 7th is preſented, the player may be required to ſet up the compleat chord of major 7th, conſidered as leading, or to be reſolved into the perfect chord of the lower note; and, upon his doing ſo correctly, will be entitled to the additional advantages correſponding to the other movements which he makes in reſolving the diſcords—otherwiſe the adverſary.

When

When the dice present a superfluous 5th or diminished 4th, the thrower, after having set up the interval, may be required to insert or to join with it one other note. If he does this properly, and if that note also moves in the resolution, he will be entitled to additional advantage; if not, the adversary.

GAME VI. *Of Modulations.* PART 1st. An exercise upon regular modulation in the major mode; or the method of passing from any key to the key of its 5th towards the one hand, or to the key of its 4th towards the other hand. This is to be played upon the circles of major fundamentals, which are upon the outer rim of the borders, that surround the two tables; the one player going along that which has signatures of sharps; and the other going along that which has signatures of flats. The object of the former is to proceed successively, by regular chords, through all the keys, according to the order by 5ths; and the object of the latter is to proceed in a similar manner, through all the keys, according to the order by 4ths. The player, who first compleats his round, wins the game. The dice used in this game are the pair No. 6 in the 4th compartment of the flat drawer, which bear upon their faces thorough bass cyphers, and the characters of sharp, flat and natural; of which the one which has the character * upon two of its faces is to be used by the player, who is to proceed by 5ths through the keys with sharp signatures; and the one, which has upon two of its faces the character ♭, is to be used by the other player—as also, the die of lines or incompleat staves. Each player sets one of the travelling pins, which lie in the 5th compartment, in C upon the border, and at the

the ſame time puts up the common chord of that key, upon his clavier; and whenever another key is gained or paſſed into, upon the clavier, the pin is moved into its fundamental. A new key is gained, when ſuch a figure is preſented by the die, as directs to play or ſet up the leading chord of a regular cadence upon that key, or what is ſometimes called its chord of dominant. This chord is that of major 3d, perfect 5th, and minor 7th, to the 5th note of the ſcale. It may exiſt in four different ſtates and may be called the chord of major 3d and 7th—chord of falſe 5th—chord of major 6th—or chord of tritone, according as the baſs note is the fundamental—the 3d—the 5th, or the 7th. When the dies preſent a 7, or ♮7, the minor 7th to the baſs note of the perfect chord, which is then upon the clavier, is to be added, or inſerted amongſt the notes of that chord. It thus becomes a chord of dominant, or the leading chord of a regular cadence upon the 4th of the former key, or the next key according to the order by 4ths; and is accordingly to paſs, or to be reſolved into that key, and the pin is to be moved into its fundamental. When a tritone is caſt up, the chord of tritone to the baſs note of the preſent key is to be played; or, the notes of the chord muſt paſs into thoſe which are at the interval of major 3d, perfect 5th and 8ve, to that note which is ſecond to the baſs note. This being duly reſolved leads into the next key, according to the order of ſucceſſion by 5ths, into which accordingly it is to paſs, and the pin is to be moved into its fundamental. A * being caſt up is an indication, that a ſharp is to be added to the ſignature of the key, which is then upon the clavier, or that a modulation is to be made into the next key of the order

order by 5ths. On the other hand, a ♭ being cast up is an indication, that a flat is to be added to the signature of the key, which is then upon the clavier, or that a modulation is to be made into the next key according to the order by 4ths. In executing these modulations, the leading chord may be played or set up, in any one of its four states or inversions. To determine which of them is to be used, or in some degree to limit the choice, the die of lines or broken staves may be thrown, which will shew the range of movement to be allowed to the bass note. Of the faces of this die, that with one line is intended to represent no interval or unison; one line and a half to represent a 2d—two lines, a 3d—two lines and a half, a 4th—three lines, a 5th, and four lines, a 6th or 7th.—When one line is cast up, the bass is not allowed to move; and in that case, modulation into the key 5th, can only be made by the chord of tritone, and into the key 4th can only be made by ♭7. When one line and a half is turned up, the bass note may move a 2d; and the modulation into the key 5th may then be also made by the fundamental chord of greater 3d, 5th and 7th, to the 2d of the scale. When two lines are presented, modulation into the key 4th may be made by the chord of false 5th, to the 3d of the present scale. When two lines and a half are presented, modulation into the key 5th may be made by the chord of false 5th, to the sharpened 4th of the present scale. When three lines occur, modulation into the key 4th may be made by the chord of greater 6th to the 5th of the present scale. Lastly, when four lines are presented, modulation into key 5th may be made by the chord of greater 6th to the 6th of the present scale; and

into

into key 4th by the chord of tritone to the flatten-ed 7th of the preſent ſcale. When the range preſented by the die affords a choice, it may be given to the adverſary, or he may direct the player by what particular inverſion of the leading chord he is to make his modulation—or, he may be obliged to move his baſs note the greateſt interval preſented by the die, by which the propoſed modulation, whether into key 5th or into key 4th can be effected. When the player upon the ſignatures of ſharps turns up a ♮, he muſt take off a ſharp from his ſignature, or modulate back to the key 4th.—When the player upon the ſignatures of flats turns up a ♮, he muſt take off a flat from his ſignature, or go back to the key 5th. The particular inverſions of the leading chord, by which theſe modulations are to be made, muſt be determined, as before, by the die of broken ſtaves. When the one player caſts up the figure 5, he may move the notes on his clavier into the perfect chord of his 5th, and when the other player caſts up the figure 4, he may move into the perfect chord of his 4th. If the ſame figure reſpectively ſhall occur at the next throw, that key may be conſidered as eſtabliſhed, and the pin may be moved into its fundamental. If any thing elſe ſhall be caſt up, he muſt return to his former or key chord, and proceed as directed by the die. The player upon the ſharp ſignatures advances in his game or gains a ſtep *forward*, when he caſts up a tritone, or *, and has a chance for doing ſo, when he caſts up 5; but he is carried *backwards*, or loſes ground, when he turns up ♮7 or ♮. Again, the player upon the flat ſignatures advances or gains a ſtep forward, when he throws ♭7 or ♭; and has a chance for

that

that when he throws 4, but is carried backwards, when he throws a tritone, or ♮. Theſe chances of being carried backwards are put upon the dies, for the purpoſe of affording exerciſe in proceeding in both directions. In order however that the game may not be drawn out to too great a length, theſe turns or retrograde movements may be regulated in the following manner.—A player is not to be turned back from his outſet or firſt ſtation; and all throws which would have that effect are to be conſidered as loſt. Each quarter of the circle is likewiſe to be conſidered as a ſtation from which, when he has gained it, he cannot be turned back; namely, the keys of 3 ſharps and 3 flats—6 ſharps and 6 flats—9 ſharps and 9 flats. In proceeding from his outſet to the firſt quarter of the circle, he may be turned back four times but no oftener—from the firſt to the ſecond quarter, three times and no more—from the ſecond to the third quarter, only twice—and from the third quarter to the outſet, only once. The number of turns, in all theſe caſes, is to be marked by putting up counters.

Part 2d. A ſimilar exerciſe upon regular modulation in the minor mode. Each player ſets out from A, the fundamental of the minor ſcale of natural notes, and they proceed through the 12 keys, the one, according to the order by 5ths, and the other according to the order by 4ths, uſing the ſame dice and obſerving the ſame rules, as in the former part.

Part 3d. The modulations practiſed in the two firſt parts, by which muſic paſſes from any key major or minor, to the next key in the ſyſtem, of the ſame ſpecies upon either hand, being

 thoſe

those which most frequently occur in music, may be called natural and regular. Music may also pass easily and naturally, by means of proper leading chords, from any major key to its relative minor, and from any minor key to its relative major. In the works of the modern composers, however, the music is often carried suddenly and unexpectedly, or by few steps, into a key which is considerably removed in the system, from that in which it had formerly been. These sudden or distant transitions are effected by various means, of which some of the most usual are—changing the mode, or going at once from the major to the minor, or from the minor to the major of the same fundamental—proceeding to the key of the minor 6th to the fundamental, of a major as well as of a minor scale—and changing the denomination, or the name of one or more of the notes of certain chords, particularly the chords of substitution or borrowed harmony in the minor mode, and the chord of superfluous 6th. To afford exercise upon this kind of modulation to those who have made some progress in the study of music, the two dies No. 7 have been provided. Upon one of these which may be called the *first die*, are the fundamental letters of all the major and minor keys, which have for signatures from one to three flats, each face presenting two fundamentals, the one with a signature of sharps, and the other with a signature of the same number of flats, and the fundamentals of major keys being distinguished by capital letters, and those of minor keys by small letters; upon the other, which may be called the *second die*, are exhibited in the same manner, the fundamentals of all the keys major and minor, which have for signatures from three

to

to ſix ſharps and from three to ſix flats. The general plan of the game may be as follows. The firſt player throws the *firſt* die, and may chuſe either the fundamental with ſharps or with flats, for the key from which he is to ſet out, and having made his election, he puts a pin into the ſame key letter in the border. The other player then throws the ſame die, and muſt take for his outſet key the one preſented, which is of the oppoſite ſpecies to that which had been choſen by the firſt player—in other words he muſt take the key with a flat ſignature, if the firſt player had choſen that with a ſharp ſignature, and contrariwiſe; and he puts a pin into the ſame letter in the border. The firſt player then throws again. If his object is to modulate into the key minor or major relative, or into a key which is at no great diſtance from his outſet, he throws the firſt die; if his object is to modulate into ſome diſtant key, he throws the ſecond die. He muſt take for the key, into which he is to modulate, the one preſented, whether major or minor, which is of the ſame ſpecies with his firſt key; and put a pin into the correſponding letter in the border. The other player does the ſame, and muſt take for the key, into which he is to modulate, the one preſented, of the ſame ſpecies with his firſt key, and alſo mark it in the border. The firſt player then ſets up the chord of his firſt key upon his clavier, and modulates or makes the notes of it paſs progreſſively into the other key, by whatever ſteps he may think proper; provided they be conſiſtent either with the ſtrict rules of muſic, or with the practice of claſſical compoſers: and for every ſharp and for every flat, which is thereby added to, or taken from the ſignature of his firſt key, he ſets up a counter. The ſecond player then

proceeds to work his modulation in the ſame manner. When a player throws next in turn, the key into which he has paſſed and which is now upon his clavier, becomes his outſet key, and he muſt modulate from that, into the key of the ſame ſpecies, preſented by the die. If his key is one of the ſecond die, he may either throw the ſame for relatives or near keys, or the other die for more diſtant keys. When the die preſents a minor or major relative to the one upon the clavier, and the modulation into that key has been made, the player may be entitled to a counter. When the outſet key happens to be one of three ſharps or three flats, the player may along with the other die, throw the die upon which are the keys of C and A; and if either of theſe keys is turned up, he may, at his option, proceed into it, or into the key preſented by the other die. The player who firſt ſets up twelve counters wins the game. When this party is played by a maſter and an advanced pupil, the different keys which are preſented by the dies to be modulated into, may afford various ſubjects of inſtruction and practice, as each throw may be conſidered as propoſing an harmonical problem, in the ſolution of which, knowledge and ingenuity may be diſplayed. A Piano-forte ought to be at hand, and every progreſſion made upon the clavier to be proved upon it. In witneſs whereof, &c.

We are requeſted to add, that the above muſical games are manufactured by Meſſrs. Muir, Wood, and Co. Muſical Inſtrument-makers to his Majeſty, No 7, Leith-ſtreet, oppoſite the Terrace, Edinburgh, and ſold at their warehouſe, wholeſale and retail, and by Mr. Thomas Preſton, Muſic-ſeller, No. 97, Strand.

V.

V. *Account of a Method of gaining Land from the Sea. By the Rev.* HENRY BATE DUDLEY, *of Bradwell Lodge, in the Parish of Tillingham.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Gold Medal was adjudged to Mr. DUDLEY *for this Communication.*

A TRACT of land, which I inclosed on the same line of coast within this parish about eleven years ago (for which I was then honoured with the Society's gold medal) being already under a profitable course of tillage, I was induced to undertake the present inclosure, as a lessee of the collegiate estate of St. Paul's. The front line of embankment against the sea is nearly one mile in length, and, with the returning banks on each wing to the old wall, forms an inclosure of contents, as expressed in the certificate already in your possession. The whole of the embankment is composed of earth alone, borrowed from the irregular salting land in the front, called *chatts*, and taken at the limited distance of twelve feet from the base of the new work, to leave a sufficient foreland for its protection. I found, from experience, in my former embankment, that I had not given it a sufficient angular declension in front, for an easy ascent and descent of the waves. This error was therefore corrected in the last work. I began it on a base of thirty-two feet, and wrought it to the height of seven feet, leaving it a plane of five feet on the top, and making

king the land-side of the embankment, as nearly perpendicular as the security of the base would allow.

Within, on the land-side, is cut a ditch, twelve feet wide, five feet deep, and four feet at bottom; the earth from which was thrown into the mound. My former sea-embankment, in Bradwell parish, had nearly given way to the great inundating tide of February 1792, from this erection of new earth being made on the surface. To guard against similar danger in the present work, a spit-deep trench, six feet wide, was previously cut along the centre of the whole line, on which the mound was to rest; this, by admitting the new earth into an incorporative adhesion with the base soil, renders a future separation almost impossible. Before this, the main rills had been filled and rammed, to give these parts equal solidity with the rest.

The whole operation was performed by a gang of twelve sea-wallers, with barrows and planks only, at one pound ten shillings the marsh-rod, of twenty feet, and perfectly inclosed in seven months: but, it must be observed, that the soil, composed of rich vegetable matter, is without one particle of stone or gravel, and cuts with an iron-edged scoop-tool, so as to load the barrows with great facility. At each end of the front line is laid an out-fall gutter, or sluice, through the whole embankment, five feet in width, by three feet deep, clear in the run; and another of smaller dimensions in the centre, for discharging the land-waters freely to sea. The construction of these aqueducts is too well known to require farther description here: probably, however, the little addition given to those erected on this occa-

sion

ſion may be found of ſome uſe. Obſerving it often happen, that, either from accident or deſign, the outward lid of the ſea-ſluices remained open, and admitted the tide to the great injury of the freſh waters within the marſhes, I introduced here a light fly-lid within the centre of each ſluice, which is out of reach, and yields to the ſlighteſt preſſure of the water going out; but ſhuts cloſely againſt that of the tide, when it paſſes inwardly the external flap. Theſe ſluices are laid upon as ſolid a foundation as can artifically be made on ſuch ſoils, to prevent the crabs, and other ſea-fiſh, from undermining them, which muſt otherwiſe be the caſe. The frame and flooring are of fir, which lies under water as durable as oak.

The land thus incloſed is partitioned into four nearly equal parts, by new out-ditches, twelve feet wide, five deep, and four at the bottom, which, with ſmall interſecting rills, from various parts, give the whole a good drainage of its ſalts, on the fall of heavy rains: and, by a courſe recently made from a diſtant brook, each diviſion of this land is now amply ſupplied with freſh water. Not leſs than eight hundred South-Down ſheep, and from ſixty to eighty horſes, are almoſt conſtantly grazed, and even winter thereon remarkably well. The eſtabliſhed opinion of the beſt farmers of the country was, that land, thus taken from the ſea, would not grow corn under thirty years at leaſt after their incloſure. But as no experiment had been made, by which this fact could be clearly aſcertained, as ſoon as I had ſhut out the ſea from a part of it, about ſix yards ſquare were immediately dug, and ſown with horſe beans and oats, which, though the ſummer proved

proved very dry, and consequently unfavourable, produced of each a fair return of sound good corn; and the last harvest the same spot being sown with wheat, yielded an excellent crop. The next spring I mean to try it with barley and turnips. My first inclosed lands in this parish have produced two succeeding crops of fine oats, and are now growing a very promising breadth of rape for seed.

It may here be remarked, that the lower oozy parts of the new inclosure, on which no vegetable ever grew before, begin to be coated with various grasses; and as the saline parts die away in other spots, for want of their natural moisture, fresh grasses replace them, so that the whole is now nearly covered with grazing plants of good quality, amongst which appear the different *clovers*, *trefoil*, and *rye grass*, &c. Hence I conclude, but contrary to the general opinion, that though all these grew artificially from seed sown, it does not follow of necessity that they cannot be produced without. I think that the natural operation of the sun and air upon certain soils will alone effect it; and my experience in lands taken from the sea confirms very strongly this opinion.

The Rev. J. H. Wright, in a certificate, which accompanies the above account, certified that the Rev. Henry Bate Dudley, of Bradwell Lodge, had completed an embankment, with all the sluices and other necessary works appertaining thereto, and had thereby effectually obtained two hundred and six acres of land from the sea, which he had subdivided by twelve-feet ditches into four spacious marshes.

VI.

VI. *Description of a Drag Cart, and Method of adjusting the Centre of Gravity of the Load, invented by Lord* SOMERVILLE.

WITH A PLATE.

From the COMMUNICATIONS to the BOARD of AGRICULTURE.

PLATE II. Fig. 1. is a perspective-view of a cart, for a single horse, calculated to carry 35 cwt. in the front of which is represented the method of adjusting the position of the centre of gravity of the load to prevent its pressing too much on the cattle in going down hill, the front of the cart being elevated by means of a toothed rack screwed to the front of the cart, and worked by a pinion, and the handle *a* immediately connected with the shaft *e*. By means of this pinion and racks, the front of the carriage is elevated, more or less, in proportion to the declivity of the hill, by which means the weight of the load is made to bear more on the axis, and less on the horse.

On the side-view of the cart is represented the manner of applying the *friction-drag*, which is made to press, more or less, on the side of the wheel, according to the steepness of the descent: *b b*, is the friction-bar, or drag; one end of which is connected with the tail of the cart by a small chain, and the other end to the front, by means of a toothed-rack *b d*, which catches on a

 staple

ſtaple in the front of the cart, by which the friction-bar may be made to preſs on the ſide of the wheel, more or leſs, at the diſcretion of the driver; the notches of teeth in this rack ſhould be as cloſe to each other as circumſtances will permit.

The friction-bar is here applied lower upon the wheel than was at firſt propoſed, in order to divide the preſſure and friction more equally on the oppoſite ſides of the wheel, ſo that the preſſures on each is diminiſhed; the riſk of over-heating and deſtroying the friction-bars is alſo rendered leſs than if the whole preſſure was applied in one point at the top of the wheel *.

Fig. 2, is a view of a drag-cart calculated to carry 25 cwt.

As the advantages of the friction-drag have been fully ſtated in Mr. Cumming's obſervations on wheel-carriages †, it would be ſuperfluous to repeat them here.

* It has been ſomehow hinted, " That a drag, ſomewhat ſimilar to that which is here deſcribed, had been uſed in the Durham coal-pits; but admitting this to be ſtrictly true, it can in no degree detract from the merits of him who has produced a contrivance that promiſes to be of much public utility, without the knowledge of what may, or may not, have been uſed in the Durham coal-pits, or elſewhere; but what opinion muſt be formed of the *inattention* of that perſon who, knowing that ſo uſeful a contrivance was uſed in a coal-pit, never diſcovered the very uſeful purpoſes to which it was applicable in agriculture! Many are the uſeful contrivances that frequently preſent themſelves to our notice, yet paſs unobſerved for ages; very few things occur that are abſolutely new; the chief merit of invention and ingenuity conſiſts in applying things that are known, in the moſt ſimple and judicious manner, to the moſt uſeful purpoſes to which they are the moſt applicable, and beſt ſuited.

† See vol. XIII, p. 327, of this work.

By

By an attentive comparison of carts drawn by shafts with those drawn by the yoke and bows, the superiority of the pole to the shafts *, and the advantage of making the cattle draw by the yoke, in preference to drawing by the forehead, become evident.

When cattle draw by the shafts, (the one before the other,) it is impossible for the driver to know that each exerts an equal force, so as to contribute equally to the draught; but when they draw by the pole and yoke, the point of draught being in the middle of the yoke, when the beasts draw equally, the yoke will stand square with the pole, and the position of the yoke will always enable the driver to discover the defaulter, and to bring it to a proper exertion: it is this harmony of draught, and equality of exertion, that gives so great an advantage to drawing by the yoke, that it is scarcely possible to say what weight of a load two good large oxen can draw on a level road. The powers of cattle drawing by the forehead, on Lord Shannon's estate, are recorded by Mr. Young and Mr. Billingsley: an ox of the late Mr. Tattersall, near Ely, drew four ton of wood on a level surface without apparent difficulty. What then might not be expected from the equal exertions of two such powerful animals, acting at the equal ends of the same yoke!

* The apparatus for adjusting the centre of gravity of the load may in such case be fixed to the pole of the cart, in the same manner as above described, to be fixed on the shaft.

VII. *Experiments and Observations on the Atmosphere of Marshes.*

By Adam Seybert, *M. D.*

From the Transactions of the American Philosophical Society.

WHEN inquiries which have attracted the attention of a Franklin, a Priestley, an Ingenhouse, and many other eminent persons, without being decided, are undertaken by one whose abilities are so far inferior as mine, little success can be expected. This remark announces the difficulty of the subject I am about to investigate; nevertheless I am stimulated by the industry of my predecessors, and if I cannot promise much new matter, I hope to be at least able to verify some observations, and perhaps disprove others; for in proportion as we remove errors we approach nearer to truth.

When we are fully persuaded, that to live and to breathe are synonymous terms; and that the absolute necessity of air to the maintenance of animal life has been fully established by repeated and well-concerted experiments, we need not be surprised to find many persons engaged in an examination of the chemical qualities of our atmosphere: the names of Scheele, Priestley, Lavoisier, Fontana, &c. will for ever make this branch of science respectable.

From the earliest ages it has been supposed that the atmosphere has great influence on the human body in producing disease, as well as in restoring health;

health; hence the accounts of Hippocrates, Sydenham, and Huxham. Phyſicians ought always to notice the ſtate of the atmoſphere during the prevalence of epidemic diſeaſes.

Before facts were collected, and experiments well performed, the atmoſphere was ſuſpected to differ materially in almoſt every ſituation; but latter experiments have proved that our notions have been erroneous to a great degree.

In a former memoir, which I had the honour to read before this Society, I paid particular attention to the atmoſphere over the ocean, rivers, and neighbouring land, and hope that my experiments have been of ſome ſervice towards the eſtabliſhment of truth; in the preſent eſſay I intend giving an account of ſome experiments which I performed at different times on the air over marſhes.

A few general remarks reſpecting the common ſtate of our atmoſphere, perhaps, become neceſſary for the ſake of future compariſons.

We no longer believe, for experiments have taught us the contrary, that our atmoſphere is an homogeneous element: the preſent ingenious doctrines of heat have thrown much light upon the ſubject; and with much reaſon ſome philoſophers are induced to believe "that the aëriform ſtate is a modification of bodies, dependent on the degree of temperature, and on the preſſure which theſe bodies undergo *!" This opinion has been extended ſo far as to induce ſome to ſay, "Perhaps alſo metals are contained in the atmoſphere †." Theſe ſentiments do not appear to be

* Lavoiſier's Elements of Chemiſtry, p. 59.

† Gritauner's Antiphlogiſtiche Chemie, p. 58.

be merely conjectural, for Chaptal has precipitated mercury from oxygen gas (which was obtained from red precipitate) by means of ice; and the family of Achard ſuffered ptyaliſm, from breathing in an atmoſphere where mercury had been expoſed for ſome time in a ſaucer.

The above opinions, if true, (and I think them highly probable,) prepare us to meet many difficulties in the analyſis of the atmoſphere. But all I expect to do is to open the paſſage, and I ſhall leave others to render it more certain; for numerous experiments, and thoſe often repeated, are the only means whereby we can aſcertain truth; and I fear the labours of one man are inſufficient to perform this taſk.

I am not without hopes that others will engage in the inquiry; it is of importance to every citizen, more eſpecially ſince we find that our principal cities are almoſt yearly afflicted with a terrible epidemic, which has been by ſome attributed to the ſtate of the air. Future diſcoveries, it is hoped, will multiply the number of teſts for airs, and thus render the ſubject more eaſy.

Reſpectable chemiſts have determined the component parts of our atmoſphere to be

Oxygen gas 27.
Azotic gas 72.
Carbonic acid gas 01.

Any deviation from this ſtatement muſt be attributed to local circumſtances.

I ſhall firſt endeavour to determine, whether or not the air of marſhes differs from that of other ſituations:

2. What are the cauſes of the differences which are found to exiſt: and

3. Make a few obſervations and remarks.

1. March

1. March 31, 1798. Air was obtained by agitating ſtagnant water over marſhy grounds; the following experiments were then performed.

a. It burned when a candle was applied to it; the flame was blue: it did not explode when mixed with atmoſpheric air.

b. Agitated with lime-water, a copious white precipitate was formed.

c. Its bulk was conſiderably diminiſhed by agitating it with lime-water.

d. Equal bulks of it and nitrous gas were introduced into my eudiometer tube, and a diminution of $\frac{2}{130}$ of their bulk was perceptible.

Theſe experiments were frequently repeated, and the reſults were ſimilar to the above-mentioned: they warrant the following inferences:

a. That carbonic acid gas enters largely into the compoſition of the air examined.

b. That hydrogen gas is an ingredient in it.

c. That no oxygen gas was preſent: for the ſmall abſorption which took place I attribute to the action of the water with which the airs were agitated.

The above experiments were performed on the air, which was obtained immediately as it was diſengaged from the marſhy ſoil; it became neceſſary to examine the air ſituated at ſome diſtance above the marſh.

At different times, during the ſummer of 1798, I collected air from the above marſhy grounds; the following experiments were performed on it.

a. When agitated with lime-water, it afforded a precipitate, which was not ſo abundant as in the former experiments.

b. Mixed

b. Mixed with nitrous air, its bulk was diminiſhed to almoſt as great a degree as the air in the yard of my lodgings.

c. Either pure or mixed with atmoſpheric air, it did not burn or explode when a candle was applied to it.

Hence it appears, that the air obtained at the height of ſeveral feet above marſhes,

1. Contains little or no hydrogen gas.

2. That the proportion of carbonic acid gas is pretty conſiderable; and

3. What is of great conſequence to be obſerved, a large quantity of oxygen gas enters into its compoſition.

The laſt-mentioned facts induce us to believe, that the air *above* marſhes is not conſiderably different in its properties from the common atmoſphere in other ſituations, where animals reſpire with eaſe, and enjoy perfect health, except the proportion of carbonic acid gas being greater; and this, I am induced to believe, diminiſhes in quantity as we aſcend: for facts related by travellers, who have viſited the Grotto del Cane, and other ſimilar places, prove that the gravity of this elaſtic fluid permits it to riſe but to an inconſiderable height.

After having proved that certain qualities do exiſt in the air over marſhes, which are different from thoſe poſſeſſed by the atmoſphere in other ſituations, we muſt next attend to our

Second object, *viz.* to aſcertain what are the circumſtances about marſhes which produce ſuch effects?

Before we proceed any further, it is of the greateſt importance to be ſatisfied reſpecting the changes

changes which may be produced on common atmospheric air, when subjected to the action of the soil of marshes.

TO BE CONCLUDED IN OUR NEXT.

VIII. *On the Decomposition of the Sulphate of Iron and Copper by Means of the natural Calx of Manganese. By Mr.* FISCHER, *of Berlin.*

From SCHERER'S CHEMICAL JOURNAL.

ACCIDENT led me to these experiments. I had, for a different purpose, let a solution of sulphate of iron, to which I had added two parts of calx of manganese and half a part of muriate of natron, to one part of the crystallized salt of iron, stand for several days in a moderate temperature. After the mixture had stood for this space of time, I found it considerably tinged with a reddish yellow colour, and a considerable quantity of calx of iron had separated itself in a completely oxydated state. My first idea was, that it had acquired oxygen from the calx of manganese, in consequence of which it had been separated in an insoluble form. However, upon adding a quantity of carbonate of lime to the liquid, a precipitate was formed, which might almost have been mistaken for a pure calx of iron; but, upon a more accurate examination, it was found to consist, for the greater part, of imperfect calx of man-

manganefe, and a fmall quantity of a perfect calx of iron. This unexpected phænomenon induced me to make the following experiments.

One part of the vitriol of iron of commerce, containing copper, which had alfo been employed in the firft cafe, with two parts of natural calx of manganefe, and half a part of muriate of natron, were expofed in a glafs retort to a red heat. An extremely fmall quantity of muriatic acid gas was extricated. After the extrication of gas had ceafed, the retort was cooled and broken, and the mafs that had been melted together was boiled out with hot diftilled water. The refiduum was found to be calx of copper, iron, and magnefia; but the filtrated fluid, on the contrary, which was perfectly colourlefs, contained no calx of iron, as appeared by proving it with the folution of pruffiate of kali, for a precipitate of a light red colour was formed, which was completely diffolved by the addition of more water. It therefore contained pure calx of manganefe, partly combined with fulphuric acid, but for the greater part with muriatic acid, befides which the folution contained fulphate of natron.

Thefe carbonates of kali and natron precipitated from this folution a perfectly white carbonated calx of manganefe, which, however, in the courfe of time affumed a brownifh yellow colour. Carbonate of ammonia added to the fluid produced alfo the fame effects.

I became doubtful whether the calx of manganefe, thus obtained, was entirely free from iron, as it appeared to become coloured by the contact of the air, which might eafily proceed from the prefence of iron; however, I found, when the alkali was not added in exceffive quantity, but

but in ſuch proportion as not to be able to precipitate the whole of the calx of mangaheſe, that the precipitate, after having been edulcorated and dried, retained its white colour without alteration.

I am much inclined to account for the firſt appearance, by ſuppoſing a complete oxydation of the calx of manganeſe, which perhaps obtained oxygen from the ſuperabundant addition of alkali; for that the alkalies really contain oxygen, ſeems to me to be proved by various facts, amongſt which I alſo reckon the great change which ſiliceous earths undergo in being heated with the alkalies.

I farther mixed one part of pure ſulphate of iron with four parts of calx of manganeſe, and expoſed this mixture, for the ſpace of half an hour, to a ſtrong red heat. A portion of the ſulphuric acid was, by this means, volatilized, but that which remained was found, after boiling out the torrefied pulverulent maſs, to be combined with calx of manganeſe, completely free from iron, in which the pruſſiate of kali produced a clear, light red, and eaſily ſoluble precipitate. The undiſſolved reſolved reſiduum was perfect calx of iron and manganeſe.

Sulphate of copper, in the ſame proportion with calx of manganeſe, and treated in the ſame manner, afforded the ſame reſults. The reſiduum contained calx of copper, undecompoſed calx of manganeſe, and, in the latter, always an admixture of calx of iron.

Poſſibly theſe experiments may procure us the advantage of being able to exhibit the calx of manganeſe free from iron, in an extremely cheap

manner, and to employ it as a cheap and agreeable glafs-flux for earthen-ware and china.

By the method firft mentioned, the fulphate of iron is never completely decompofed by the calx of manganefe; for, by conftant boiling for four hours, and afterwards digefting for twelve days, I could effect no complete feparation of the iron, though, after this treatment, it is contained in the folution as completely oxydated iron. I have found, by repeated experiments upon this fubject, that the decompofition may be completely effected in the dry way, by the application of a red heat for the fpace of fifteen minutes.

IX. *An experimental Enquiry concerning the Solution and Oxydation of Mercury.*

By Mr. SCHMIDT, *Apothecary at Sondefburg.*

From SCHERER'S CHEMICAL JOURNAL.

IN preparing the red oxyd of mercury, (red precipitate of mercury,) the idea had frequently occurred to me, whether the nitrous acid that paffes over might not ftill be employed for other fimilar purpofes, or more mercury employed for folution. Time and circumftances did not at firft permit me to enter upon the inveftigation of this fubject, which afterwards ceafed to engage my attention, till the obfervations of Van Mons upon the oxydation of mercury, in this Journal, vol. II. p. 742, which fo entirely coincided with what I had

had formerly ſuſpected, recalled my thoughts to it, and I now felt a more urgent impulſe to inſtitute a more accurate enquiry into the ſubject.

I therefore firſt ſubjected, according to the old method commonly in uſe, one part of mercury, and two parts of the common aquafortis of the ſhops, to diſtillation, in order to examine, whether the acid, which is carried over, might not ſtill be employed once more, or perhaps oftener, for the ſame purpoſe. After the diſtillation, I found that the loſs of aquafortis amounted to no more than four ſcruples in the ounce. To this I added three drachms more of freſh mercury, and my expectations were completely fulfilled; the mercury was completely diſſolved, and the fluid that was carried over amounted to ſix drachms all but one ſcruple, which, as the acid did not yet ſeem to have entirely loſt its powers, I mixed ſtill with three drachms of mercury, in order to carry my experiments to this ultimate point. Here, however, my expectations failed: ſcarcely two drachms were diſſolved, and amongſt this ſalt I found globules of liquid mercury, which, being accurately weighed, amounted to ſixty-ſix grains; and the fluid that had paſſed over no longer exhibited any traces of predominant acidity.

After having repeated theſe experiments ſeveral times, and always with the ſame reſult, I took equal parts of mercury and common aquafortis, as the former experiments clearly proved that this completely diſſolved, and conſequently oxydated the mercury, put both together into a retort, and ſubjected them to diſtillation. I again obtained a perfect nitrate of mercury, but the nitrous acid that was carried over was far leſs in weight than before,

before, which was to be attributed to the greater quantity of mercury that had been employed. I then mixed the acid that had passed over once more with half the quantity of mercury; but now nine scruples remained undissolved in the retort out of one ounce of mercury.

These experiments sufficiently convinced me, that the common aquafortis of the shops is able to dissolve only a little more than an equal quantity of mercury: I therefore thought proper to try the *double* aquafortis, (*aquafortis duplex*,) and the concentrated fuming nitrous acid (*Acidum nitri concentratum*). But also the experiments which I made with those afforded me little more dissolved mercury than the common single aquafortis had done: a drachm of fuming nitrous acid dissolved only four scruples of mercury, all of which, under the extrication of a large quantity of nitrous gas, was converted into a dry saline mass, to which no artificial heat could be applied. Double aquafortis was more convenient for my experiments, as it produced no constant extrication of vapours; however it dissolved and oxydated no larger a quantity of mercury than had been done in the former processes.

It now therefore only remained for me to try the purified acid of nitre; and it was necessary for me to make the experiment also with this, in order that I might be able to draw certain inferences from my experiments. I therefore purified good common single aquafortis again over dry saltpetre, put the fluid which first passed over apart, and employed only that which followed for my experiments. Their result was as follows.

1. Equal

1. Equal parts of mercury and purified acid of nitre immediately diſſolved in the cold, under an extrication of nitrous gas, in a glaſs veſſel, and yielded a white ſalt, over which ſtill one ſcruple of fluid ſtood; this I poured anew upon half a drachm of mercury, which likewiſe was entirely converted into a ſaline maſs.

2. Half an ounce of purified aquafortis and an ounce of mercury were likewiſe completely diſſolved, without the application of artificial heat.

3. I then poured half an ounce more of this aquafortis and two ounces of mercury into a ſmall retort, in which I let them remain incloſed over night, and, on the following morning, I found that ſix drachms were diſſolved. I then fixed a receiver to the retort, and applied a gentle heat; however, no more mercury was diſſolved; I therefore poured the remaining crude mercury into the fluid that had paſſed over into the receiver, in which, upon the application of heat, two drachms were again diſſolved, ſo that in all an ounce of mercury remained undiſſolved *.

After having made theſe experiments, I endeavoured to avail myſelf of the hints which Van Mons gives in the above-mentioned article in Scherer's Journal, namely, "To perform the ſolution and oxydation of the mercury in an open

* Note of the Author. It is not yet entirely clear to me, from whence it proceeded, that the whole of the nitrous acid did not at firſt ſaturate itſelf with mercury, and that the fluid that paſſed over ſtill diſſolved a portion of mercury, as was the caſe in all the proceſſes before mentioned. Perhaps the nitrous ſalt of mercury that had ſeparated itſelf from, and covered, the metallic mercury, prevented the nitrous acid, that was now left in a weak ſtate, from acting upon it.

veſſel,

vessel, which enables us to stir the mass, and divide the mercury." An evaporating dish of porcellain was chosen for this purpose: I began the solution at a low temperature, and gradually increased the heat, at the same time keeping the mass in constant motion by stirring it; however all my labour was in vain. I obtained nothing more than what the preceding experiments had already exhibited, and the supposition of Van Mons, "That, by proceeding in this manner, it might be possible to oxydate at least 50 parts of mercury with 20 parts of moderately concentrated nitrous acid," was proved to be groundless. I obtained indeed a very good oxyd; but the mercury that was not dissolved had escaped in increasing the temperature.

However, if we take the proper proportions of acid and mercury, and manage the fuel properly, this mode of proceeding is the most convenient, easy, and advantageous. By constant stirring, every part of the mercury is exposed to the action of the acid; the whole process is completed in a few hours, and a considerable saving of fuel is made.

Inferences.

From all the experiments hitherto mentioned, I deduce the following inferences.

1. That the common, not purified, aquafortis of the shops, both single and double, can dissolve and oxydate well only equal quantities of mercury; but that one part of purified aquafortis can dissolve and oxydate two parts of mercury.

2. That consequently purified aquafortis, free from all admixture of muriate and sulphuric acid, is the best adapted for the solution of mercury.

3. That

3. That the ſolution of oxydation of mercury, performed in open veſſels, effects nothing more than that which is performed in cloſe veſſels; but that, for the reaſons already adduced, it is more advantageous to perform the operation in open veſſels *.

4. That it is advantageous, when this operation is performed in cloſe veſſels, to reſerve the acid that paſſes over from the mercurial oxyd, for new ſolutions of mercury; or alſo to make uſe of this fluid in preparing the white precipitate of mercury, as always a portion of diſſolved mercury paſſes over together with it, which affords a white precipitate with muriate of ammonia and carbonate of kali.

5. When too much mercury was employed, I did not obſerve that it paſſed over into the receiver in the metallic ſtate, but it was always at firſt covered by the mercurial ſalt, and upon increaſing the temperature, it was raiſed indeed, but it depoſited itſelf in a half calcined ſtate upon the upper part of the retort, in the form of a greyiſh-white ſublimate. The very trifling quantity of metallic mercurial globules that paſſed over was immediately diſſolved by the diſtilled acid contained in the receiver.

* Note of Prof. Scherer. "In the ſame manner I alſo diſſolve the ſulphate of mercury, complete the operation in a few hours, which, when performed in cloſe veſſels, occupies ſeveral days, on account of the difficulty with which the concentrated ſulphuric acid paſſes over, and nevertheleſs obtain Turpeth Mineral of the fineſt yellow colour.

X. *Account of Experiments made on the Files of Citizen* Raoul *and those of English Manufacture* *.

From the Registers of the Lyceum of Arts.

FRANCE has long been furnished with files by the English. The superiority and beauty of the English files were universally acknowledged, and we consumed annually to the value of several millions of livres.

Citizen Raoul, a French artist, desirous of procuring to his country the same superiority in this manufacture which it already possessed in many others, has succeeded in manufacturing more beautiful and better files than those with which England has hitherto exclusively furnished us.

Comparative trials have already been made and repeated. The most eminent artists have given their opinion in favour of the files of Citizen Raoul; and the Lyceum adjudged an honorary crown to him on the 10th of Thermidor, year 8, upon the report of its commissaries, who had verified this discovery.

* This account being highly interesting to the Manufacturers of Files in England, inasmuch as it tends to shew them the danger to their trade, arising from zealous and ingenious foreign competitors, who, (if the facts related be well founded) appear to have made extraordinary progress towards the perfection of the art, is given here with the sole view of putting the English artist upon his guard, and of stimulating him to such exertions as shall prevent the loss of that export trade which hitherto has been preserved by the superiority of his workmanship.

It

It is well known, that even amongst the best English files it is difficult to make a selection of any number that shall prove all of equal quality; whereas those of Citizen Raoul, on the contrary, have been found to be all of uniform goodness.

The Lyceum of Arts, one of the principal objects of whose institution was to give publicity to national discoveries, conceived that a sure means of producing an universal conviction of the superiority of Citizen Raoul's files would be to call upon all artists, amateurs, and all the directors of large manufactories, to make a comparison of them.

The Lyceum therefore invited all persons who interest themselves in the progress of the arts and the honours of the French nation, to bring the best English files which they possessed, and to put them in competition with files of the same grain manufactured by Citizen Raoul.

The competition took place on the fourth complimentary day of the year 9.

Citizen Mulot, Ex-president in the chair, and in the presence of Citizen Gillet Lamont, Commissioner appointed by the government.

Citizen Balthazard, junior, watch-maker, presents a file, which is recognized by the company to be an English one, and marked T; it is a smooth of four inches; Citizen Bourdies, watch-maker, presents another, marked B. T. Bramall.

A citizen, who had travelled in England, and been conversant in the English manufactories, comes forward to examine these files, which he recognizes to be really English.

Experiment I. The grain of the file preſented by Citizen Balthazard, junior, is examined, and matched with one of Citizen Raoul's files: ſome of the artiſts preſent obſerve that the grain of the latter is rather coarſer, which gives the Engliſh file the advantage in the proof. Citizen Meyer, watch-maker, makes the experiment; the Engliſh file whitens *(blanchit)*. Citizen Balthazard himſelf makes the ſame experiment upon both ſides, both of his own file and of that of Raoul, and the ſame effect is produced.

A Citizen requeſts that more experiments be made, in order that no room may be left for doubt; poſſibly, he ſays, it might otherwiſe be ſuſpected that the Engliſh file has not been tempered; ſeveral other citizens obſerve, that ſuch a fact could not exiſt, as the file had filed effectively, and only whitened, which could only happen in conſequence of its having been tempered.

Experiment II. The file of Citizen Bourdier is brought to the trial; it is endeavoured to match its grain with ſome of Raoul's files, but none is found exactly ſimilar to it.

Experiment III. Citizen Petit, an artiſt belonging to the manufactory of arms at Verſailles, preſents a file marked T; it is endeavoured to match its grain; the choice having been made, Citizen Petit acknowledges that his file is finer than that oppoſed to it by Citizen Raoul; the aſſembly verifies and admits this fact, from whence it follows, that the proof is made in a manner unfavourable to the file of Citizen Raoul; Citizen Petit tries the files himſelf, and acknowledges that the ſuperiority is entirely on the ſide of the

files

files of Citizen Raoul, and that in a very ſtriking manner; the experiment was made by commencing alternately with one of the ſides of each of the files that were put to the proof.

Experiment IV. Citizen Provoſt preſents ſeven files, which he ſays he has poſſeſſed fifteen years, and procured them directly from Engliſh manufactories. Their denomination and marks are as follows.

1. A ſmooth ½ round, 8 inches, marked G.
2. Smooth, 7 inches, marked B. Bramall.
3. Ditto, baſtard, 6 inches, marked B*.
4. Ditto, round, 4 inches, marked B*.
5. Ditto, 3 ſquare baſtard, 3½ inches, marked B*.
6. Ditto, round ſmooth, 3 inches, marked I. P.
7. Ditto, flat ſmooth, 3 inches, marked T.

Experiment V. No. 1, is brought to the proof, and matched. Citizen Lenoir makes the experiment; the Engliſh file ſoon whitens, whilſt that of Citizen Raoul does not, and thoſe who examine it declare it to be excellent.

Experiment VI. No. 2, is put in competition with a ſtronger file, which gives the advantage to the Engliſh file; it ſuſtains the trial better than the preceding ones; however that of Citizen Raoul ſeems to deſerve the preference: the aſſembly then demanded that theſe files ſhould be tried upon a higher tempered ſteel; the Engliſh file whitens, that of Citizen Raoul completely reſiſts in two trials. Citizen Tournu, mechanic, makes the firſt trial, Citizen Provoſt makes the ſecond.

Experiment

Experiment VII. No. 4, is put to the proof by Citizen l'Epine, watch-maker, Place des Victoires, at first upon steel moderately tempered; the files sustain the proof almost in an equal degree, that of Citizen Raoul has the advantage: the experiment is repeated upon harder steel; the advantage still remains, and that in a more decided manner, with the file of Citizen Raoul.

Experiment VIII. No. 3, is matched with a file of Citizen Raoul, of a rather stronger grain; Citizen Bourdier, watch-maker, Quai d'Horloge, makes the experiment; and having tried the experiment upon the first steel, without any decided advantage appearing on either side, he employed harder steel, upon which the English file No. 3, whitened completely, but that of Citizen Raoul resisted in the most perfect manner.

Experiment 9. No. 5, being matched, the experiment is made by Citizen Sallot, watch-maker, at first upon steel moderately tempered; upon the first stroke, the English file whitens; that of Citizen Raoul resists completely.

Experiment X. No. 6, is matched in the same manner. Citizen Schey, manufacturer of cut-steel, *Faubourg St. Denis*, makes the experiment, at first upon steel of the softest kind; no decided advantage results to either of the two files; he then repeats the experiment upon harder steel; the English file whitens at the first stroke, that of Citizen Raoul resists.

Experiment XI. No. 7. Citizen Salneuve makes the experiment with this file, the best of those presented by C. Provost. At the first stroke upon steel of moderate hardness the English file whitens;

whitens; that of Citizen Raoul resists completely, and to that degree that one cannot distinguish which of its three sides has been used for the experiment.

Experiment XII. Citizen Fouverel, watchmaker, Palais de Tribunal, presents an English file, marked B. T. Bramall, of 8 inches, it yields upon steel of the softest quality, and whitens completely upon more highly tempered steel; it is observed that Citizen Raoul's file alone resists both trials.

As none of the persons present offered any more files for comparison, after having been repeatedly invited to do it by the president, the secretary having read the minutes of each experiment, the assembly adjourned.

XI. *List of Patents for Inventions, &c.*

(Continued from Vol. XV. Page 432.)

James Tremeere, of Lambs Conduit-passage, Middlesex, Carpenter; for a method of working barges and other vessels. Dated October 5, 1801.

William Bullock, of Portland-street, Soho, Middlesex, Cabinet-maker; for a fastening to be applied to sashes or dining-tables. Dated October 8, 1801.

Samuel Miller, of Cleveland-ſtreet, St. Pancraſs, Middleſex, Engraver: for a machine and proceſs for manufacturing materials for the better ſecuring walls and roofs of houſes from lateral preſſure, and the inclemency of the weather, by which proceſs the buildings will be built of better materials, and rendered more durable. Dated October 13, 1801.

William Symington, of Kinnaird, Stirlingſhire, Engineer; for a mode of conſtructing ſteam-engines, and applying their power to the purpoſe of producing a rotary and other motions without the interpoſition of a lever or beam. Dated October 14, 1801.

Thomas Fryer, of Raſtrick, near Halifax, Yorkſhire; for a method of manufacturing and finiſhing goods from cotton, cotton and woollen, cotton and ſilk, cotton and linen, or cotton and mohair, in ſuch manner as to make the ſame appear as if covered with ermine or fur, and in imitation thereof. Dated October 30, 1801.

Richard Brayshay, of Liverpool, Lancaſhire, Gentleman, and William M'Mahon, of the ſame place, Gentleman; for a machine for the purpoſe of gaining an increaſed ſpeed and power to all mechanical operations by land and water. Dated October 30, 1801.

Printed by Nichols and Son, Red-Lion-Paſſage, Fleet-Street, London.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XCII.

Printed by NICHOLS and SON, Red-Lion-Paffage, Fleet-Street, London.

XII. *Specification of the Patent granted to Mr.* JOHN KENDREW, *of Darlington, in the County of Durham, Optic Glafs-grinder, and Mr.* THOMAS PORTHOUSE, *of the fame Place, Clock-maker; for a new Mill or Machine, upon new Principles, for fpinning Yarn from Hemp, Tow, Flax, or Wool.*

Dated June 19, 1787.—Term expired.

WITH A PLATE.

TO all to whom thefe prefents fhall come, &c. NOW KNOW YE, that in compliance with the faid provifo, they the faid John Kendrew and Thomas Porthoufe do hereby defcribe and afcertain the nature of the faid invention, and in what manner the fame is to be performed, as follows; that is to fay: The machine may be worked or ufed by a water mill, horfe mill, or any other kind of mill, and is made and ufed as hereafter defcribed in the two drawings or plans added hereto, and figured 1 and 2, and feverally

 marked.

marked. There is a cylinder, as marked A in the drawing Fig. 1, (see Plate III.) three feet diameter and ten inches broad, made of dry wood or metal, turned true, and covered on its circumference with a smooth leather, upon which are placed the rollers marked D, covered with leather, and supported in their situations by the slits in the covered piece of wood marked K, in which the iron axes of the rollers turn, but suffers them to press on the wheel marked A. There must be another piece similar to the above to support the other end of the rollers. These rollers are of different weight. The upper roller marked D 1 is two stone, the rest decreasing to the last, which is only two pounds weight and one half. There is an iron fluted roller, marked F, furnished with a toothed wheel at each end, and a wood one, marked G, covered with cloth, and over it a smooth leather. There is an assisting roller, marked H, of fluted iron. These rollers are supported by their axes, turning in the slit, marked 2, of the piece of wood marked M, (Fig. 3,) which is here separated from the end of the frame marked 8, to shew the rollers and wheel-work. The rollers marked G and F are squeezed together by means of the lever marked *p*, and its weight marked *w*, (Fig. 3). The roller marked H is pressed to the mark G by its axis acting upon the inclined plane marked *x*, (Fig. 3). There is a rubbing roller covered with woollen cloth, and on its axis is a small wheel, marked I, driven by the wheel marked S. This roller rests upon the roller marked G, and by its motion prevents any dirt or fibres from adhering to it. There is a cloth, marked N, revolving over two rollers marked O, O, which has motion given to it from

from the wheel marked C, by means of another wheel marked P. This cloth moves at the same pace as the surface of the wheel marked A. There is a supporter, marked Y, of the axis of the wheels marked O P, but is removed, in order to shew them; it is fixed by its tenons in the mortices marked Z, Z. The roller marked B is kept in action by its endeavour to slip down the inclined plane at the top of the piece marked Y, thereby pressing against the revolving cylinder; and another piece, similar to this, must be understood to support the other end of the roller's axis. By the side of this revolving cloth is a table placed, of the same length and breadth as the cloth is, to which belong two smooth cloths or leathers, of the same size as the table. The machine being thus prepared, the attendant or workman must take a quantity of hemp, tow, flax, or wool, more or less, according to the fineness of the thread to be made, and lay or spread it evenly upon one of the smooth cloths on the table, then place it on the revolving cloth marked N, motion being communicated to the roller marked F, by wheel-work, as usual, from a water, horse, or other kind of mill, which wheel-work is communicated to the wheel marked Q, on whose axis is a nut, which turns the wheel marked C; and thereby the cylinder marked A moves, and with it all the rollers, by which motion the hemp, tow, flax, or wool, is drawn forward. The cloth turns down, but the hemp, tow, flax, or wool, go upon the cylinder marked A, under the roller marked B, and so forward under all the rollers marked D, then falls in between the rollers marked G F, turns under the roller marked G, and over the roller marked H, which, as it gives the

rollers hold of the hemp, tow, flax, or wool, in two places, enables them to drag forward the long fibres thereof, though many of them are to draw from under the marks 4 or 5 of the pressing rollers, marked D; it then falls into a cannister, marked R, and as by the wheel-work the rollers marked F, G, H, move three times faster than the cloth and cylinder, the sliver must be three times longer than when presented. By the time this is drawing, the other cloth is filled with hemp, tow, flax, or wool, as before, and laid upon the revolving roller, laying the hemp, tow, flax, or wool, over the end of the other, which goes forward as before, and thus a continued sliver is produced as long as the machine continues its motion. But in order that this sliver may come out of the cannister marked R without entanglement, it must pass through an instrument marked 5, (Fig. 3,) placed over the rollers marked F, G, its open side marked T, to the cylinder at mark 4, supported by its ends marked V, V, in the slits marked W, of the before-described pieces marked K.. The apperture marked X is so small as to press the fibres close to each other in their passage through it previous to their passing the rollers, by which means they remain pressed side by side in the sliver, and will not entangle. These thick slivers are drawn smaller by a similar process, and in the same manner as used for cotton, but the machines for drawing are all of the same structure as the above, except that they have no revolving cloth. The sliver is applied to the cylinder under the roller marked B, which draws it forward under all the rollers, as before described, drawing it out, or lengthening it, every fresh machine through which it presses, till

it

it be small enough for the spinning machine. It must be remarked, that the cylinders are made less in diameter, according to the different smallness of the sliver intended to be drawn upon them at the first; whilst the sliver is at its greatest thickness, the cylinder is required to be three feet diameter, as above described, the next rather less, and so on to the last, which is only two feet. The apperture of the bottom of the contractor belonging to each machine is also made one-third part smaller than another in succession, from the greatest to the smallest cylinder; as also the drawing rollers marked F, G, H, are farthest from the pressing roller marked D in the longest cylinder, and nearest at the smallest cylinder. At the largest cylinder the distance is about nine inches, and the smallest about four inches; but their distance cannot in all cases be fixed, as it depends on the different length of the fibres of the hemp, tow, flax, or wool; long ones requiring the distances mentioned, and short ones requiring the distances much shorter than is here specified.

The following several letters or marks are in the machine figured 2. The spinning machine, as to its drawing principle, is the same as the drawing machine. The slivers are presented to it in cannisters marked A, and drawn over a cylinder marked B, covered with rollers marked D. The fibres which are to form the thread are drawn from the cylinder by the rollers marked C, the under roller of which is made of fluted iron, the other of wood, covered with leather; they move six or eight times faster than the cylinder marked B; are enabled to draw the hemp, tow, flax, or wool, forward from under the pressing rollers marked D,

by

by being ſqueezed together with the weights and crooks marked *a*, *a*, hooked to the ſmall part ſo the rollers marked C. There is a belt of ſmooth cloth, marked E, moving on two rollers, which are turned by the wheel marked F on the axis of the fluted roller; at the oppoſite end of which, as at the mark G, is a nut, which turns the wheel marked H, on whoſe axis is another nut, turning the wheel marked I, and thereby the cylinder marked B, with all its rollers. Theſe rollers move in curved pieces of wooden metal, marked K, which, to prevent confuſion, are not repreſented in their places; they have ſlits in them, in which the roller's axes are guided, but ſo deep as at all times to ſuffer the rollers to preſs upon the cylinder. Theſe rollers are covered with cloth and leather. The top roller is about ten pounds weight, decreaſing to the ſixth roller, which is only about one pound weight: the yarn is turned by the ſpindles marked L, and rubbed over the wet cloth belt if ſpinning linen yarn, but if ſpinning worſted yarn the belt muſt be removed, that it may not touch it as it paſſes to the ſpool, which it coils round as faſt as the rollers let it out. The ſpindles marked L are turned by a belt from the wheel marked M, which derives its motion from the mill, and by a wheel on its axis communicates it to the roller under the mark C by the wheel marked F, and ſo to the reſt, as above deſcribed. The hemp, tow, flax, or wool, is twined in the ſame manner as cotton is by mills. In witneſs whereof, &c.

XIII.

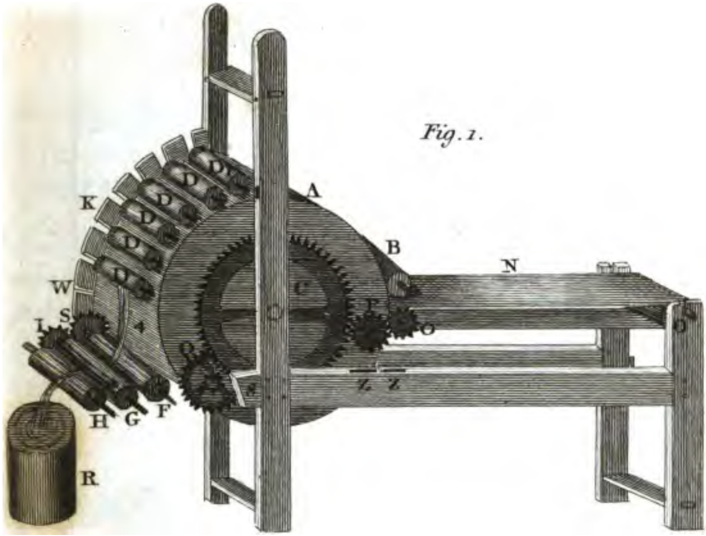


Fig. 1.

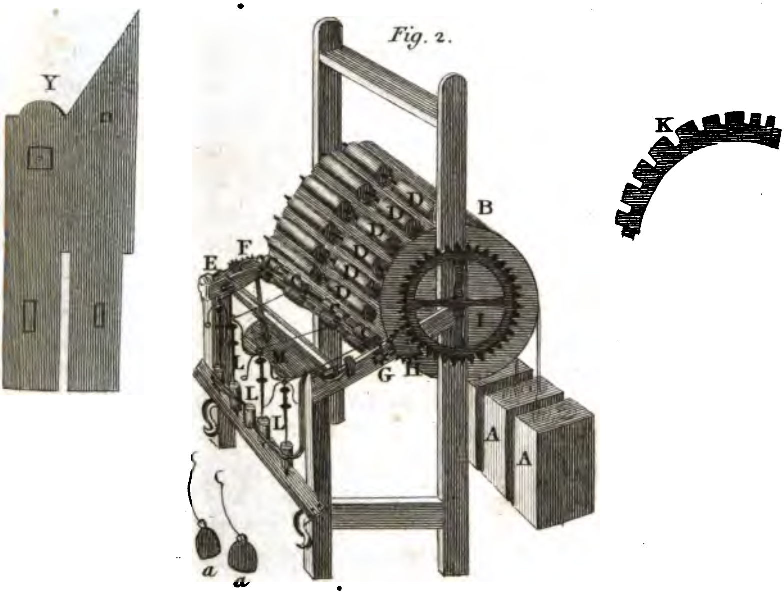
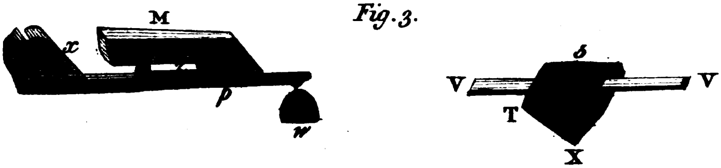


Fig. 2.

Fig. 3.



XIII. *Specification of the Patent granted to Mr.* Zachariah Barratt, *of Gedling, in the County of Nottingham, Cabinet-maker; for a more simple, concise, and cheap Method of grinding Corn, or other Grain, than has been hitherto used, by a new Mill or Machine, either moveable or immoveable, and intended to be worked by Water, Wind, Horses, Hand, or otherwise.*

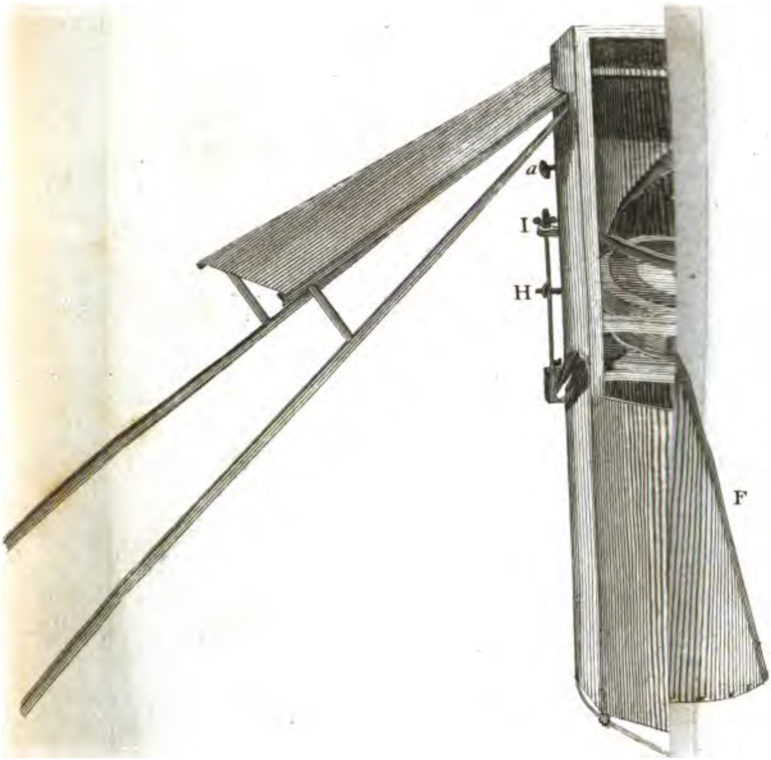
Dated September 18, 1801.

WITH A PLATE.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said Zachariah Barratt do hereby describe and ascertain the nature of my said invention, and in what manner the same is to be performed, by the plan or drawing in the margin of these presents, (see Plate IV.) and in manner following; that is to say: This mill may be conveniently erected in a garden or croft, wherever the wind has access, and is so light as to be capable of being turned by the hand, or the sails may occasionally be affixed in a horizontal position to the upright shaft; and on taking down the shed over the mouth-hopper, the power of a horse may be applied when the wind fails. It will perhaps be necessary, on this occasion, to have the wheel A, Fig. 1, enlarged, which may be readily effected by screwing on an additional wheel in quadrants or octants, as may be preferred. The whole apparatus may be conveniently fixed on a centre, with a gudgeon at each end, to the gable end of a house, barn, or grainery, a peculiar provision being planned in the sails for that

that purpose. It will appear obvious, that its internal construction is suited to any power which may be substituted for the sails; and it will be superfluous to hint to a workman, how hand mills may be connected with the crown and spur-wheels at the same time to grind malt, split-beans, cut hay, straw, &c.

Fig. 1, A, is a crown and spur-wheel; it has three concentric circles, 1, 2, 3, with teeth adapted to the spur-wheel above, on the mill-shaft, the teeth in the second being higher than the first, and in the third higher than the second, to meet the elevation of the mill-shaft above the plane of the crown-wheel. These circles are called the speed-wheels, serving to increase the velocity of the stones, or to preserve it when the velocity of the wind decreases. This wheel may be dispensed with, with one or two pair of stones, the nut on the spindle, being made contrate instead of spur, and immediately connected with the spur-wheel, affixed to the axis of the mill by means of a sliding box A, (Fig. 2,) and screwed in its position by the screw S, (Fig. 2,) by which it is adapted to each of the concentric circles, as the crown-wheel is required to move faster or slower. C, is the brake-wheel, which retards or stops the motion of the sails by its friction with the wedge W. (See for its position on the axis Fig. 2.) D, is a circular plate of cast-iron, belonging to, and being part of, the iron axis of the mill-shaft, or the upright axis of the crown-wheel. Upon this plate, on the continuation of the spindle, (see *d*, Fig. 2,) is placed the cross Fig. 4, to which it is fastened by four screws passing through the four holes of both; and the extremity of the arm of each sail into which the said cross is inserted at the



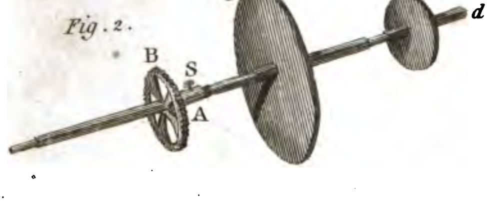


Fig. 2.

the ſlot *f*, (Fig. 3,) and ſecured by another ſcrew and moveable iron bandages. E, is the gallows, which ſupports the gudgeon of the mill-ſhaft, which, moving on a centre at the ſmall end, permits the ſpur-wheel to be thrown in or out of gear by means of the wedge at the other end. The ſtones moved by the nut *s* are placed in a box in the frame G, fixed on a platform *m*, which, ſliding on the rails *n*, *n*, the ſpindle is thrown out of gear by the ſcrew H paſſing through the iron rod, which, by the ſcrew I, raiſes or depreſſes the bridge tree. *a*, is an iron axis, with ſmall wheels at each end, for turning a ſifting machine.

Fig. 3, is the ſail-arm, into which, at the mortiſe *a*, is put the ſupporting arm D, at its end *b*, and ſcrewed by a peg: the fixed part of the ſail E falls into the ſlot C, and is kept in its poſition by the guards *d*, and a peg in the groove B. The two other fan-ſails F, F, ſlide on each ſide of the fixed one, moving on a centre at the narrow extremity, and, when expanded to the wind, are kept in their poſitions by pegs in the ſame groove catching in the notches at the other extremity: theſe ſails are made of thin boards. When the ſails are affixed to a gable-end, whence it will occaſionally be neceſſary to catch the wind on oppoſite ſides of the ſail, the ledge *e* is attached to each ſail-arm into the nicks, on which falls the ſpring *m* of the adjoining ſail, by which means the ſails are turned to oppoſite degrees of obliquity. The frame of the machinery, as depicted in the ſpecification, turns on caſtors, on a circular baſe. In witneſs whereof, &c.

The Patentee desires to inform the publick, that he has erected a mill, of the above description, at his house at Gedling, near Nottingham, and has various models, open for the inspection of such persons as may wish to take that trouble. These mills may be adapted to be worked either by rivulets or the wind: in the latter case they may be erected on the stem of a standing tree, or the gable end, or corner of a house, barn, or other building, in any of which situations the whole apparatus for grinding, &c. may be contained within the attic or other room.

The price of the above mills, adapted to gable ends, to work only one pair of grey stones, of not more than 30 inches diameter, is 35 guineas; if with a preparation for other machinery 3 guineas more. Those to be erected on the ground, adapted either for wind or water, will be from 45 to 60 guineas; and if two pair of stones, dimensions as above, from 15 to 20 guineas extra; if of larger sizes, the price will advance in proportion.

The mills on the ground may be made either portable or immoveable, on posts, and when boarded forms a complete house, under the works, for the miller, and a receptacle for his flour.

These mills, according to the size of the stones, will turn off as much work as any mills on the old construction. The prices mentioned are exclusive of any water-works, carriage, or fixing.

XIV. *Specification of the Patent granted to Mr.* JOHN BAPTIST DENIZE, *of Paris, now reſiding in George-ſtreet, Portman-ſquare, Chemiſt; for a Cement for various Purpoſes.*

Dated July 16, 1800.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid John Baptiſt Denize do hereby declare that my ſaid invention of a new cement for various purpoſes is deſcribed in manner following; that is to ſay:

PRELIMINARY OBSERVATIONS.

Convinced by repeated proofs that the decay of mortars or cements in general uſe, occaſioned by the alternate or combined effects of damp and dry weather, was owing chiefly to the bad choice and imperfect preparation of the matters they are compoſed of; that their difficulty in adhering with any ſtrength to various materials indifferently, but particularly to wood, to preſerve it from rottenneſs and worms, and to iron, to prevent its growing ruſty, was owing to the want of viſcoſity and clammineſs in the fixed air, and to the water and ſalts which conſtitute their glutinous quality; and perſuaded therefore that ſubſtances of a more fixed and identical nature, combined and glued together by a viſcous body, unalterable in itſelf, and yet ſufficiently unctious and penetrating, ſo as to incorporate eaſily with the various objects on which it might be applied, would, on the contrary, form a compoſition the

more uſeful and valuable as it would then poſſeſs qualities intirely oppoſite, I applied myſelf in the reſearch of that object; and, after repeated eſſays (of which I ſhall hereafter give an account, as belonging to this ſubject), I ſucceeded in finding out the peculiar nature, proportions, and preparation, of theſe ſubſtances; the exact combination of which aſcertains definitively the utility of my proceedings.

Indication of fixed matters. The materials which I employ in preference to thoſe of which I ſhall afterwards give a liſt, agreeable to my foregoing obſervations are, *viz.*. Firſt, all the various ſpecies of ſcorious matters, metallic ſcums, or droſs of iron, and generally all other kinds of remnants or file duſt found in forges and founderies, containing a great deal of metallic ſubſtances, adulterated by the effect of combuſtibles, principally iron, in very great quantities; or, inſtead of thoſe various ſubſtances, old iron reduced to the ſame ſtate by calcination, and pulverized by the effect of heat and charcoal; and all kinds of metallic duſt and filings more or leſs reduced to that ſtate; and in general every other produce of nature or of art in which metallic ſubſtances, eſpecially iron, are found in a ſtate of calcination, and chiefly carbonate. Secondly, all volcanic products, called aſhes of volcanos, and lava; particularly thoſe which are reduced to the greateſt ſtate of attenuation, ſuch as pozzolana and pumice-ſtone; inſtead of thoſe volcanic matters, one may almoſt as effectually employ ochres, and other ferruginous earth, particularly yellow oxide of iron, (as painters make uſe of), or reddiſh brown oxide, when calcined by the ſame degree of heat as that of a potter's kiln, or at leaſt ſufficient to reduce

reduce those substances to a state of demi-vitrification; or what remains after the distillation of acid nitre, by the means of bolar-earth, cleared of that acid by a strong calcination, and mixed with sulphat of iron, equally dissolved by the same means, and known in commerce by the name of caput-mortuum of aqua-fortis, and of colcothar; or also all ashes produced from the incineration of vegetables, especially those of pit-coal, and charcoal of the hardest wood, from the identity of nature which subsists particularly between that species of ashes and the above-mentioned volcanic matters; or those various terreous and metallic particles which it has been proved by analizing that the above-mentioned lava and ashes were composed of; such for instance, as silex, or quartz, that hard vitrifiable earth alumine, or pure clay lime, or chalky clay, magnesia, and baryta, or terra-ponderosa, and manganese, or any other metallic particle, especially iron; the whole mixed in proportions, more or less conformable to those which constitute the volcanic and vegetable ashes which I mentioned before, and calcined the same as ochres by a degree of heat sufficient to bring those particles more or less to that state in which they are by nature found, contained in those two kinds of produce; and in general all other combinations, whether natural or artificial, which, from the proportions and identity, or analogy of their terreous and metallic particles, with those I have already mentioned, could produce the same effects; in this I comprehend, therefore, not only the various matters described in the list subjoined to this specification, from reason of their being composed of the particles alluded to, but which I partly exclude from the composition of this cement, on account

count of the defects which I have found in them; but alſo, all other kinds of compoſitions whatever, of a nature more or leſs analagous with thoſe I have juſt now deſcribed. Thirdly, Pit-coal of a flat hard nature, and that kind particularly which has a brightneſs in it like Kendal-coal *: and fourthly, glaſs, or flint ſtone.

Indication of glutinous matters. Firſt, ſublimated ſulphur: ſecondly, bitumen, made of pit-coal; in lieu of it either of thoſe ſubſtances that derive therefrom, claſſed in the following order; *viz.* petrol, mineral, pitch, naphta, aſphaltos, or any other modification of pit-coal bitumen, equally proper to replace ſaid ſubſtances; thirdly, tallow-pitch, known alſo under the name of pitch-roſin, and white-roſin, and in ſhort every kind of reſinous ſubſtance, whether natural or factitious, more or leſs analogous in its conſiſtence and effects to the above ones; ſuch as pitch, and tar, and every other produce of that kind: and, fourthly, that mucilage produced by the decoction of linſeed, after it has been boiled ſufficiently to a degree of conſiſtence of about twice the thickneſs of the white of an egg; inſtead of that mucilage, that of any other ſeed, plant, or animal ſubſtance ſuſceptible of producing the ſame, or the equivalent, either of themſelves or by the effect of their combination; or ſuch mucilage as might be made out of various kinds of indigenous or exotic gums, whether reſinous or not, with meal and feculum and other ſimilar ſubſtances; or one may uſe alſo linſeed oil, or any other kind of oil, or greaſe, of a deſiccative and mucilaginous nature, ſuch as is extracted from poppies, nuts, pinks, &c. or

* We preſume the author means Cannel-coal.

other

other vegetable and animal oils or greafe, that are not by nature deficcative, but which may be rendered fo by their combination with other fubftances compofed of deficcative principles, fuch as the various kinds of gums, and wax, fpermaceti, oils of turpentine, or thofe matters from which they are extracted; oxides and acids, or any other deficcative fubftance whatever.

Preparation of fixed matters. In order better to impregnate thofe fixed matters with the gluten which is to combine and unite them together, they muft be firft prepared as follows: *viz.* the drofs of iron, the pozzolana, and pumice ftone, or the other kinds of metallic fcums and volcanic matters, muft be well cleared of all faline, terreous, fulphureous, ftony, or other particles extraneous to them, and reduced to a powder as fine as that of well-calcined afhes; and the afhes which might be fubftituted to the above-mentioned volcanic products, or thofe terreous and metallic particles which I alfo indicated as a fubftitute to thefe, muft be calcined till they become white, provided they have not already undergone that operation by fire; then wafhed in lye, to extract by thefe two operations the fulphats and falts which might be mixed with them, and afterwards well dried and fifted. With regard to pit-coal, glafs, or flint ftone, they muft alfo be reduced to a very fine powder like that of afhes and fifted afterwards.

Preparation of the gluten. Take fublimated fulphur in the proportion of one-eighth more or lefs to the quantity or volume of cement which you intend to make, mix with it one third more or lefs of pit-coal bitumen, then let it diffolve on a flow gradual fire till it infenfibly rife up in momentary bubbles; ftir

ſtir the mixture during that time, and when it is compleatly diſſolved take it off the fire and add to it, whilſt you continue to ſtir, one third more or leſs of black pitch; then ſet it on the ſame ſlow fire again till it has riſen up gradually as before; take it then once more off the fire, and add one twentieth more or leſs of the total weight of fixed and glutinous matters, compoſed of a mixture of two equal portions of good tallow, or any other hard greaſe, and of white clear roſin or wax, and mix then the whole on the ſame fire again till it is perfectly diſſolved and combined together; or in order to render the cement more fluid, and thereby more eaſy of application, to the one-eighth in volume (not in weight) of ſublimated ſulphur well diſſolved, with the one third of pit-coal bitumen, add one third part, in volume alſo, compoſed of one ſixth part of the above-mentioned roſin or wax, and of one ſixth part of good tallow melted together; and after you have well mixed the whole on the fire, add one more third part, in volume alſo, compoſed equally of one-ſixth part of pit-coal bitumen well mixed together whilſt cold *; or inſtead of this a ſame third part, in volume always, of linſeed oil, or of any other deſiccative oil, and laſtly, one more third part compoſed of two portions, equal in weight, of black pitch and of roſin melted together: and after you have equally well mixed theſe matters with the reſt, and ſtirred the whole on a ſlow fire for a while ſufficient to unite and combine them perfectly together, uſe this bituminous compoſition or the one preceding in the manner indicated hereafter.

* A ſixth part of ſome other ſubſtance appears to be omitted.

Compoſition

Composition of the cement. To either of the two glutinous compositions above mentioned, made perfectly liquid by fire, add at several times, in order the better to combine them together, the following proportions of fixed matters, well mixed and sifted together: viz. three-fourths in volume (not in weight) of dross of iron, one-eighth of pozzolana, and one-eighth of pumice-stone, or the same quantity of two substances the most analogous to those volcanic matters, such as I have mentioned as substitutes for them, one-eighth of pit-coal before named, and one eighth of glass or flint stone; let the whole boil on a fire sufficiently great to keep those materials in a state of fusion, but not so much as to cause the volatile principles to evaporate, which must be guarded against. Stir now and then so as to bring the fixed matters up from the bottom to the surface in order to combine them better, and after three or four times boiling, for that cement made with the first kind of glutinous composition, or double that time for that made with the other kind, make a trial of it by laying some of it on wood, and passing the trowel with which you stir hard over it, to judge whether and how much it requires longer to be boiled. One sees that it is done, when after being laid on the wood it becomes hard as it gets cold, and that though still warm it does not stick to the hand, with which you must therefore press hard upon. If one should delay too long to make that trial, the cement might be boiled too much, which would then take from its viscosity, and would make it necessary to remedy this by the addition of one twentieth part of the weight of it, more or less, according to the degree of its adulteration, of either tallow, bitumen, or pitch. But if the cement does

 not

not poſſeſs the above properties when that trial is made, it muſt then be boiled, ſtirring it always till it has acquired the ſame. In general the more equal the fire is, the better will the cement be, provided the volatile principles do not evaporate. It would on that account be adviſeable to boil that compoſition by the heat reſulting from boiling water and in an uncovered veſſel, for by that means this compoſition would be rendered (even ſhould a great proportion of glutinous principles be added thereto) extremely compact, and as hard as it may be wiſhed, without depriving it (for all that) of thoſe unctuous and penetrating qualities which render it ſo valuable.

Manner of employing the cement. It is firſt broken in ſmall pieces, then you add to it one fortieth part, more or leſs, of its weight of good tallow, or other hard greaſe, or inſtead of them not quite a fortieth of black pitch, aſphaltos, roſin, or wax, or only half that proportion of pit-coal bitumen, mineral-pitch, naphta, or ſome deſiccative oil: but if it was intended to employ that cement (eſpecially that made with leſs glutinous principles) for the purpoſe of joining or cementing more quickly, it would then be proper to add one half more than the fortieth part of the above-mentioned matters. The whole is then melted and liquified for a quarter of an hour in an earthen veſſel, or one of caſt iron, whilſt you continue to ſtir it on a ſlow fire, or what would be better, on the heat of boiling water, the ſame as it is done for glue; after which you take that compoſition from the bottom of the veſſel whilſt you ſtill continue to ſtir, and make the application of it immediately. It is neceſſary to obſerve that when the cement appears to become too dry, from its long continuance on the

fire,

fire, one must then add to it a small portion of the matters before mentioned, in order to give it that unctuous quality again, and to keep it so in that state during the time that you make use of it. Experience will however better teach what proportion of these matters will be required occasionally, and their choice.

Secondary methods of making this cement. As the composition of this cement may be varied by the different choice and proportions of glutinous matters relatively to the more or less fixed nature of the others, and by the boiling it for more or less time, as I have myself ascertained the same by many experiments, (for instance by the composition and application of that cement without the use of fire,) I reserve to myself the privilege of those various modifications as being a direct practice of that same theory and appertaining necessarily to this invention. With regard to the various substances which I used in my different essays, and which I found less proper for the composition of this cement, they are as follow; viz. charcoal and soot, and even glass flint, whether calcined or not, potter's earth, brick, tile, slate, clay, marl, the various species of gravel or sandy stones, lime or calx, plaster, sand, oyster-shells, or any other shells when those substances are used exclusively or in too great proportions. In witness whereof, &c.

XV. *Specification of the Patent granted to Mr.* JOHN WILKINSON, *of Broſeley, in the County of Salop, Iron-Maſter, for a Method of making Lead Pipes.*

Dated March 13, 1790.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid John Wilkinſon do hereby declare, that my ſaid invention of a new method of making lead pipes is deſcribed in the manner following; that is to ſay: I caſt the lead in lengths, as is practiſed in the common way, *i. e.* put upon a poliſhed rod or round maundrell of iron, or any metal, ſuch maundrells being made of different lengths and diameters, according to the ſize that is wanted. This rod or maundrell, with the caſt-lead upon it, is put repeatedly through or between rollers, with grooves, of different ſizes, according to the external diameter required, and extended to the length or thickneſs ordered; or drawn through metal gauges or collars, of different dimenſions, upon the ſaid maundrell, each ſucceeding collar being leſs than the former, until the ſame is extended to the length and thickneſs required; all of which may be performed with a common water wheel, or any other rotative motion. In witneſs whereof, &c.

XVI. *Experiments and Obſervations on the Atmoſphere of Marſhes.*

(Concluded from Page 57.)

AT different times in the months of September and the commencement of October 1796, I expoſed atmoſpheric air to the action of mud, which I obtained from marſhes below the city. The ſame was done at different times in the months of April and July, 1798. The experiments were expoſed to the temperature of the atmoſphere. The reſults from the different experiments were ſimilar. The air was expoſed to the action of the mud which was contained in a tumbler, by means of an inverted glaſs jar, in a baſin containing a ſmall quantity of water. The following changes were noticed.

1. The air contained in the jar became much diminiſhed in bulk, as was proved by the water riſing into the jar.

2. The air, thus acted upon, when agitated with lime water, afforded a copious white precipitate, and became diminiſhed in bulk.

3. In ſome of the jars, were ſuſpended papers, ſtained blue with litmus and yellow with turmeric, the blue received a reddiſh tinge and the yellow remained unaltered; the red was again changed to a blue by expoſure to the vapour iſſuing from a bottle containing ammoniac.

4. The air thus altered by the mud, when mixed with nitrous gas in the eudiometer tube, was in every inſtance found to have loſt in point of purity; ſometimes no diminution of bulk whatever took place.

The

The following circumftances feemed to influence the laft-mentioned experiments. 1ft. Temperature. 2d. The length of time during which they were continued. And 3d. The proportion which the mud and air bore to each other, the furface of the mud being more or lefs extenfive, feemed alfo to have its effects.

The air thus affected by the action of the mud would in no inftance burn or explode, when a candle was applied to it; hence it contained but a fmall quantity of hydrogen gas.

This laft-mentioned fact induced me to engage in an effay to determine the origin of the hydrogen gas which abounds in the *air obtained by agitating ftagnant waters.*

It is neceffary to be obferved, that in the above experiments with mud, but a fmall proportion of water was added to it in the tumbler, the quantity was juft fufficient to promote putrefaction. I am of opinion that the hydrogen gas is afforded by a decompofition of the ftagnant water, effected by the putrefaction of the dead animal and vegetable fubftances, which enter largely into the compofition of the foil of marfhes. I was induced to form this opinion, becaufe, firft, pure water is a compound of but two elements, confequently the affinity cannot be broken but by the action of a third fubftance. And fecondly, we have no experiments which prove that pure water has undergone fpontaneous decompofition. My ideas are confirmed by a fact well known to all feamen, viz. when a candle is applied to the bung hole of a cafk containing *river water*, which had been for fome time clofely ftopped, an elaftic fluid efcapes, which will inflame and appears in all refpects fimilar to hydrogen gas obtained by other means.

After

After forming the above conjectures, I determined to perform a few experiments which might tend to confirm or diſprove my opinion. With this view mud and water, with a very ſmall portion of atmoſpheric air, were at different times confined in bottles cloſely ſtopped and inverted over water: in ſome inſtances the experiment was continued during 20 and 30 days. They were ſubjected to the temperature of the atmoſphere. During the progreſs of the experiments, I perceived that an elaſtic fluid was diſengaged from the materials contained in the bottles, and that the water was evidently diminiſhed in bulk; the elaſtic fluid generated during theſe experiments, 1ſt, inſtantly formed a copious white precipitate when agitated with lime water; 2dly, it burned, when the flame of a candle was applied to it, and poſſeſſed the other properties, which are common to air obtained by agitating ſtagnant waters over marſhes.

Theſe facts are deciſive to me on the ſubject, and confirm the above conjectures reſpecting the origin of the hydrogeng as diſengaged from marſhy grounds. It is neceſſary to remark, that ſome danger attends theſe laſt experiments; for a large bottle which was cloſed by a ground ſtopper, was broken on the 25th day of the experiment, by an expanſion of the contained elaſtic fluid: the pieces, which were large, were thrown to the diſtance of 20 feet, and a report was heard louder than that from the firing of a muſket. In general, the bottles had corks faſtened by means of ſtrings bound round them: as ſoon as I cut the ſtrings, the corks were forced from the necks of the bottles with conſiderable violence.

The

The above experiments teach us that mud vitiates the atmoſphere in a very powerful manner. They alſo enable us to account for the preſence of the elaſtic fluid forming the atmoſphere of marſhes. It appears, that the carbon of the mud unites with the oxygen of the decompoſed water, and forms the carbonic acid gas, whilſt the hydrogen gas is ſet at liberty. Theſe are truths not to be invalidated by gratuitous aſſertions, ſince their baſis is experiment.

It may be aſked, if mud ſeizes oxygen gas with the avidity ſtated, how comes it that eudiometrical experiments prove the air over marſhes to be nearly, if not quite, of the ſame degree of purity as that of other ſituations?

At firſt an anſwer to this important queſtion may ſeem difficult; but ſome examination of the circumſtances attending the ſituation of marſhes, enables us to account for it in a very ſatisfactory manner. It is to be remarked that in my trials with mud, the air was confined under glaſs veſſels over water, conſequently no circumſtances from without could have any influence on the experiments. The air over marſhy ſituations is very different, it poſſeſſes all the advantages of ventilation, &c. in common with the atmoſphere. Beſides theſe circumſtances, a large quantity of oxygen gas is afforded by the living vegetables which ſurround them in abundance. We may alſo obſerve, that frequently large ponds of water are found in their neighbourhood, and that often rivers are at no great diſtance from them: may not therefore a quantity of oxygen gas be diſengaged from theſe waters by the action of the ſun? Experiments are related by reputable authors,

thors, wherein water has been decomposed by the action of the sun's rays; of this more hereafter.

That the atmosphere of marshes, therefore, differs in certain circumstances from that of other situations, and that the soil has considerable effect, in altering the air of the atmosphere, I think, cannot be doubted. Let us therefore endeavour to discover the particular local causes which give rise to these variations.

I have before hinted that the putrefaction of the animal and vegetable matters upon the soil of marshes, was the great cause of the changes observed to exist: for every species of soil will not operate in the manner alluded to.

That the cause is in the putrefaction of these matters, and that this state is absolutely necessary to those changes, I infer from the following circumstances; marshes have no noxious influence, during the winter season. They cause disease when the circumstances are present which promote putrefaction; as, a proper degree of heat, a due quantity of moisture, and the contact of atmospheric air or substances capable of affording oxygen; as *water*. That a certain degree of moisture is necessary, appears evident from White's experiments, related in the Philosophical Transactions: he says, "a certain degree of moisture seems necessary to produce the bad effects of marshes; for mud when perfectly dry did not alter the air." He might have added, that too much fluidity will likewise prevent their bad consequences, which is proved by the neighbourhood being healthy when they are overflowed. An overflow of water may operate by preventing the powerful effects of the sun. Experience teaches us, that their bad effects are discontinued, when they become dry. Cover-

ing them with clay and other ſubſtances not liable to putrefaction, deſtroys their bad effects, ſo does cultivation, froſt, &c.

Living trees being planted in their neighbourhood renders the ſituation more healthy, by abſorbing the gas exhaled during putrefaction and affording oxygen gas.

White's experiments prove, " 1ſt. During ſixteen hours, air confined in a phial over water did not ſuffer a change. 2dly. Pure clay moiſtened did not alter the purity of the air. 3dly. Sand moiſtened did not change the purity of the air." But, 4thly, *Mud (which conſiſts of earths intimately mixed with dead animal and vegetable ſubſtances) rendered the air very impure, as I proved by the experiments which I performed.*

The following reflections occurred to me ſome time ſince, and are copied from my note book.

To arrive at any certain knowledge reſpecting the manner by which marſhes can be ſuppoſed to affect the atmoſphere, we muſt inveſtigate their compoſition.

They ſeem to conſiſt of;

1ſt. More or leſs water. 2dly. Different proportions of *dead* animal and vegetable matters. And 3dly. The earthy ſubſtances compoſing the original ſoil.

Animals and vegetables, when they have ſuffered death, are ſubject to the laws which govern inanimate matters in general, and they are liable to the various changes produced by chemical mixture and the laws of chemical affinity: they are acted upon by the powerful agents of nature, and thus ſuffer decompoſition, and form new combinations.

All

All chemists acknowledge the analysis of animal and vegetable substances to be imperfect. Lavoisier has paid particular attention to the subject. He performed numerous and accurate experiments to determine their composition, and notices in a particular manner the results they afford during their putrefaction. According to him, they consist chiefly of hydrogen and oxygen, combined with carbon: these substances, he says, are found in all vegetables, and none exist without them. Animal substances contain more hydrogen and azot than vegetables do, they also have carbon as a constituent part of their composition; some of both classes contain sulphur and phosphorus.

The above are the principles which I suppose are liable to be acted upon, and thus produce the effects we are about to consider.

Before we can understand the changes to which the above substances are liable, we must take into consideration, that our atmosphere is composed of the azotic and oxygen gases, and a small portion of carbonic acid gas: many view this last as adventitious and by no means necessary.

Heat, moisture, the contact of atmospheric air and rest we know are circumstances attendant on marshy situations during the unhealthy seasons.

A priori, we might be induced to believe that the following phænomena would take place, under the above circumstances.

1. That hydrogen gas would be disengaged. 2, That the oxygen combining with the carbon would form the carbonic acid gas. 3. That azot would unite with a portion of hydrogen and thus produce ammoniac; whilst another portion of it would, during its combination with oxygen, form the nitric acid. And, 4, That when sulphur or

phosphorus were present, they with hydrogen would form the sulphurated and phosphorated hydrogen gases.

We shall now endeavour to discover whether or not these elastic fluids enter into the composition of the atmosphere of marshes.

1. Hydrogen gas. Doctor Franklin has long since demonstrated the production of this elastic fluid in marshy situations. Ingenhousz and others have confirmed the truth of his experiments and observations.

My experiments convince me that it is produced in a considerable quantity, and that it may be easily procured by agitating stagnant waters over marshes. It is also evident that this gas is in a state of mixture with the carbonic acid gas.

Although we are certain that a large quantity of hydrogen gas is disengaged from marshy grounds, we must nevertheless conclude that it bears but an inconsiderable proportion to the atmosphere at large; for we find that the air immediately above marshes will not explode upon the approach of a candle: indeed from its levity we might suppose that it occupies the inferior strata of the atmosphere but for a short time.

2. Carbonic acid gas. That this elastic fluid enters largely into the composition of the atmosphere of marshes, is easily proved by agitating it with lime water.

3. Ammoniacal gas. The production of this gas during putrefaction, is proved beyond doubt; therefore that it should exist in the atmosphere of marshes seems at least probable, indeed many have inferred considerable effects from its presence, but as they did not detect it by any test with

with which we are acquainted, their opinion is entirely hypothetical.

The following are the results of the means I employed to discover whether ammoniacal gas is present in the atmosphere of marshes. 1. No white clouds appeared, when muriatic acid gas was mixed with air obtained by agitating stagnant waters. 2. Slips of paper stained yellow by turmeric, were suspended in a bottle containing mud and atmospheric air, it remained unchanged; whereas those stained with litmus received a reddish tinge. 3. I never could perceive the odour peculiar to this alkali when I visited marshes.

The above experiments caused me to doubt the presence of this elastic fluid in the atmosphere of marshes. I was confirmed in this opinion by the following circumstances: 1st. Ammoniac combines readily with water: it is impossible to procure ammoniacal gas over water; therefore we are to suppose, that if this fluid is produced it is immediately absorbed by the water of the marsh. 2dly. Carbonic acid gas is abundant in the atmosphere of marshes. By experiment, I ascertained that this acid and ammoniacal gas were very prone to unite, and form the carbonate of ammoniac. The experiment was performed in a glass tube over mercury: as soon as the two elastic fluids came in contact, an absorption took place, and the bulk of them was considerably diminished: at the same time the sides of the tube were incrusted with a white matter, which possessed all the properties of the carbonate of ammoniac. If such are the phænomena of these experiments, why will not similar effects take place in marshy situations?

4. Nitric

4. Nitric acid. The experiments and observations of Thouvenal and others have long since demonstrated the production of this acid during putrefaction. If it is formed in marshy situations, its presence cannot be proved in their atmosphere, and I am inclined to believe that it is immediately absorbed by the neighbouring waters.

5. Sulphurated and phosphorated hydrogen gases. If these elastic fluids consist of hydrogen gas, holding sulphur and phosphorus in solution, it seems probable that they should be generated during the putrefaction of such matters as contain them as constituent elements. Although Chaptal, in his Memoirs de Chimie, p. 141, observes, "Que la boue noire, degagée de tout "végétal, ne donnoit plus d'air inflammable "mais répandoit une odeur de foie de soufre." Still he relates no experiment whereby he detected its presence in the atmosphere of marshes. Its ready absorption by water; marsh air, when agitated with a solution of the acetite of lead, producing no change in it; silver not tarnishing sooner in these than in other moist situations; and the air possessing no peculiar smell; are all facts which tend to convince me that it does not exist; moreover, Kirwan says, that hepatic gas, united with nitrous air, will deposit sulphur. I agitated marsh air and nitrous air together in a glass tube, and no such phænomenon was noticed.

6. Azotic gas. If you burn candles in the air of marshes until all the oxygen be absorbed, and then agitate the remaining air with lime-water so as to absorb the carbonic acid, an elastic fluid still remains which possesses the properties of azotic gas.

7th,

7th, and lastly. Oxygen gas. A variety of facts prove that oxygen gas is a principal ingredient in the atmosphere of marshes; 1st, candles burn therein with the same lustre as in other situations. 2d. Animals breathe with equal ease as in other places. 3d. Eudiometrical experiments prove that it forms as great a proportion here as in other atmospheres which are reckoned more healthy.

August 4th and 5th, 1796.—July 8th and 10th, 1798.—I collected air from over marshy grounds to the south and north of Philadelphia; when tried with the eudiometer, they always proved as pure as the air in my lodgings. Chaptal, in his Memoirs de Chimie, p. 141, asserts, that the air over the ponds, which border on the Mediterranean sea, (the neighbourhood of which is equally marshy, if not more so than the neck formed by the junction of Schuylkill and the Delaware, as I convinced myself during my residence at Montpellier in the years 1795 and 1796,) was equally pure with that of Montpellier, tried the same day. When I assert that the atmosphere of marshes is equally pure with that of other situations, I mean that it contains as large a proportion of oxygen gas as such other atmospheres do. I do not by any means intend to be understood that it is free from foreign mixtures.

I have acknowledged that putrefaction is going on in marshy places, and likewise admit that this process destroys the purity of the atmosphere by absorbing its oxygen; therefore it may seem difficult to admit the *absolute purity* of the air being equal here to that of other places. People being able to breathe with ease over marshy grounds, is sufficient proof that the oxygen gas there is ade-

quate

quate to fupport life. I fhall now attempt to account for the purity of the air of marfhes as follows. Sennebier has proved, by numerous experiments, that living vegetables, placed in an atmofphere of carbonic acid gas, or in water faturated with this air, expofed to the action of the fun, thrive and grow very rapidly: during the experiments the carbonic acid is deftroyed, and oxygen gas is difengaged. In addition to thefe experiments, Ingenhoufz has taught us that the aquatic plants, particularly fuch as grow in the neighbourhood of marfhes, poffefs the power above ftated to a furprifing degree; fee Expériences fur les Végétâux, Tom. 2, p. 401. Thefe facts, when properly confidered and connected with the remarks I made when fpeaking of the effects of mud on the atmofphere, I think are fufficient to account for the phænomenon, which at firft feemed at leaft doubtful.

The above view of this difficult fubject will perhaps, in fome meafure, alter our opinions refpecting the utility of marfhes. Heretofore mankind feem to have viewed their exiftence as noxious to them, and unneceffary to their happinefs. I confefs my former opinion refpecting them coincided perfectly with that of the majority, but at prefent my ideas are very different: I confider them as very neceffary to keep the atmofphere in a *proper degree* of purity, for it is not only the impure atmofphere which kills animals, but the too pure alfo: and an ingenious philofopher has well obferved, that animals live too faft in atmofpheres over-charged with oxygen gas. They appear to me to have been inftituted by the Author of Nature in order to operate againft the powers which vegetables and other caufes poffefs of purifying

fying the atmosphere, so that the oxygen may exist in a proper proportion, fit to support animal life and combustion. I am of opinion, that ere long marshes will be looked upon by mankind as gifts from heaven, to prolong the life and happiness of the greatest portion of the animal kingdom. Perhaps it was originally intended that they should remain uninhabited, and that their only use should be that of correcting the too pure atmospheres. Although their immediate inhabitants suffer disease from them, still but a small portion of the human race choose marshy situations for their residence.

After I had read the above before the Society, a friend, in conversation with me, objected to the operation of marshes on the atmosphere being intended to prevent a superabundance of oxygen gas; he observed that this effect would be fully accomplished by the ordinary combustion and the respiration of animals. Upon reflection, his objections gave rise to new confirmations of what I asserted: I remarked to him, that very extensive tracts of country were sufficiently warm without fires; that in these places nature gave uncommon powers to vegetable action, but at the same time ordained, that in these very situations marshes should be most abundant. If we view most southern countries, I believe the above facts will be found to exist very generally. A further beautiful demonstration of my proposition may be adduced from a well-known fact, that when vegetable life becomes paralized in the winter season, the operation of marshes is then unnecessary, and is likewise suspended by the same causes, *viz.* frost, &c.

XVII. *On a new fulminating Mercury.* *By* Edward Howard, *Esq. F. R. S.*

WITH A PLATE.

From the Transactions of the Royal Society of London.

SECTION I.

THE mercurial preparations which fulminate, when mixed with sulphur, and gradually exposed to a gentle heat, are well known to chemists: they were discovered, and have been fully described, by Mr. Bayen *.

MM. Brugnatelli and Van Mons have likewise produced fulminations by concussion, as well with nitrate of mercury and phosphorus as with phosphorus and most other nitrates †. Cinnabar likewise is amongst the substances which, according to MM. Fourcroy and Vauquelin, detonate by concussion with oxymuriate of potash ‡.

Mr. Ameilon had, according to Mr. Berthollet, observed, that the precipitate obtained from nitrate of mercury, by oxalic acid, fuses with a hissing noise §.

SECTION

* Opuscules Chimique de Bayen, Tom. I. p. 346, and note in p. 344.

† Annales de Chimie, Tom. XXVII. p. 74 and 79.

‡ Ibid, Tom. XXI. p. 238.

§ This fact has been misrepresented in the introduction to a work, intituled, " The chemical Principles of the metallic Arts, by W. Richardson, Surgeon, F. A. S. Sc." page 57. The author, speaking of the acid of sorrel, says, " Klaproth, " of Berlin, precipitated a nitrous solution of mercury with " acid

SECTION II.

But mercury, and most, if not all its oxides, may, by treatment with nitric acid and alcohol, be converted into a whitish crystallized powder, possessing all the inflammable properties of gunpowder, as well as many peculiar to itself.

I was led to this discovery by a late assertion, that hydrogen is the basis of the muriatic acid; it induced me to attempt to combine different substances with hydrogen and oxygen. With this view I mixed such substances with alcohol and nitric acid as I might (by predisposing affinity) favour as well as attract an acid combination of the hydrogen of the one, and the oxygen of the other. The pure red oxide of mercury appeared not unfit for this purpose; it was therefore intermixed with alcohol, and upon both, nitric acid was affused. The acid did not act upon the alcohol so immediately as when these fluids

" acid of wood sorrel, neutralized with vegetable alkali. The " white precipitate, well washed and dried, produced a fulminating noise, not inferior to that of fulminating gold. " Acid of sugar, perfectly neutralized by vegetable alkali, " produced the same precipitate, which, on exposure to " heat exhibited the same fulminating power." I must confess, I have not been able to produce any such fulmination. Mr. Richardson has moreover given this supposed discovery to Mr. Klaproth; whereas Mr. Berthollet, when quoting the fact to which I suppose Mr. Richardson intended to allude, observes, " Qu'on avoit déjà donné le nom d'argent " fulminant au précipité du nitrate d'argent par l' acide oxalique, dans lequel M. Klaproth avoit découvert la propriété " de fuser avec vivacité lorsqu'on l'expose à la chaleur. M. " Ameilon avoit aussi, depuis longtems, fait connoître que " l'acide oxalique communiquoit cette propriete au mercure, " quoique moins fortment qu'à l'argent; mais cet effet (he " continues) est fort éloigné de celui qu'on désigné par la " fulmination." Annales de Chimie, Tom. I. p. 57.

 are

are alone mixed together, but first gradually dissolved the oxide: however, after some minutes had elapsed, a smell of ether was perceptible, and a white dense smoke, much resembling that from the *liquor fumans* of LIBAVIUS, was emitted with ebullition. The mixture then threw down a dark coloured precipitate, which by degrees became nearly white. This precipitate I separated by filtration; and, observing it to be crystallized in small acicular crystals, of a saline taste, and also finding a part of mercury volatilized in the white fumes, I must acknowledge I was not altogether without hopes that muriatic acid had been formed, and united to the mercurial oxide; I therefore, for obvious reasons, poured sulphuric acid upon the dried crystalline mass, when a violent effervescence ensued, and, to my great astonishment, an explosion took place. The singularity of this explosion induced me to repeat the process several times; and finding that I always obtained the same kind of powder, I prepared a quantity of it, and was led to make the series of experiments which I shall have the honour to relate in this paper.

SECTION III.

I first attempted to make the mercurial powder fulminate by concussion; and for that purpose laid about a grain of it upon a cold anvil, and struck it with a hammer, likewise cold: it detonated slightly, not being, as I suppose, struck with a flat blow; for, upon using three or four grains, a very stunning disagreeable noise was produced, and the faces both of the hammer and the anvil were much indented.

Half

Half a grain, or a grain, if quite dry, is as much as ought to be uſed on ſuch an occaſion.

The ſhock of an electrical battery, ſent through five or ſix grains of the powder, produces a very ſimilar effect: it ſeems, indeed, that a ſtrong electrical ſhock generally acts on fulminating ſubſtances like the blow of a hammer. Meſſrs. Fourcroy and Vauquelin found this to be the caſe with all their mixtures of oxymuriate of potaſh *.

To aſcertain at what temperature the mercurial powder explodes, two or three grains of it were floated on oil, in a capſule of leaf tin; the bulb of a Fahrenheit's thermometer was made juſt to touch the ſurface of the oil, which was then gradually heated till the powder exploded, as the mercury of the thermometer reached the 368th degree.

SECTION IV.

Deſirous of comparing the ſtrength of the mercurial compound with that of gunpowder, I made the following experiment in the preſence of my friend Mr. Abernethy.

Finding that the powder could be fired by flint and ſteel, without a diſagreeable noiſe, a common gunpowder proof, capable of containing eleven grains of fine gunpowder, was filled with it, and fired in the uſual way: the report was ſharp, but not loud. The perſon who held the inſtrument in his hand felt no recoil; but the exploſion laid open the upper part of the barrel, nearly from the touch-hole to the muzzle, and ſtruck off the hand of the regiſter, the ſurface of which was evenly indented, to the depth of 0,1 of an inch, as if it had received the impreſſion of a punch.

* Annales de Chimie, Tom. XXI. p. 239.

The

The instrument used in this experiment being familiarly known, it is therefore scarcely necessary to describe it: suffice it to say, that it was of brass, mounted with a spring-register, the moveable hand of which closed up the muzzle, to receive and graduate the violence of the explosion. The barrel was half an inch in caliber, and nearly half an inch thick, except where a spring of the lock impaired half its thickness.

SECTION V.

A gun, belonging to Mr. Keir, an ingenious artist of Camden-Town, was next charged with 17 grains of the mercurial powder, and a leaden bullet. A block of wood was placed at about eight yards from the muzzle, to receive the ball, and the gun was fired by a fuse. No recoil seemed to have taken place, as the barrel was not moved from its position, although it was in no ways confined. The report was feeble: the bullet, Mr. Keir conceived, from the impression made upon the wood, had been projected with about half the force it would have been by an ordinary charge, or 68 grains, of the best gunpowder. We therefore recharged the gun with 34 grains of the mercurial powder; and, as the great strength of the piece removed any apprehension of danger, Mr. Keir fired it from his shoulder, aiming at the same block of wood. The report was like the first in section four, sharp, but not louder than might have been expected from a charge of gunpowder. Fortunately Mr. Keir was not hurt, but the gun was burst in an extraordinary manner. The breech was what is called a patent one, of the best forged iron, consisting of a chamber 0,4 of an inch thick all round,

round, and 0,4 of an inch in caliber; it was torn open and flawed in many directions, and the gold touch-hole driven out. The barrel, into which the breech was screwed, was 0,5 of an inch thick; it was split by a single crack three inches long, but this did not appear to me to be the immediate effect of the explosion. I think the screw of the breech, being suddenly enlarged, acted as a wedge upon the barrel. The ball missed the block of wood, and struck against a wall, which had already been the receptacle of so many bullets, that we could not satisfy ourselves about the impression made by this last.

SECTION VI.

As it was pretty plain that no gun could confine a quantity of the mercurial powder sufficient to project a bullet, with a greater force than an ordinary charge of gunpowder, I determined to try its comparative strength in another way.—I procured two blocks of wood, very nearly of the same size and strength, and bored them with the same instrument to the same depth. The one was charged with half an ounce of the best Dartford gunpowder, and the other with half an ounce of the mercurial powder; both were alike buried in sand, and fired by a train communicating with the powders by a small touch-hole. The block containing the gunpowder was simply split into three pieces: that charged with the mercurial powder was burst in every direction, and the parts immediately contiguous to the powder were absolutely pounded, yet the whole hung together, whereas the block split by the gunpowder had its parts fairly separated. The sand surrounding the gunpowder was undoubtedly most disturbed:

disturbed: in short, the mercurial powder appeared to have acted with the greatest energy, but only within certain limits.

SECTION VII.

The effects of the mercurial powder, in the last experiments, made me believe that it might be confined, during its explosion, in the centre of a hollow glass globe. Having therefore provided such a vessel, seven inches diameter, and nearly half an inch thick, mounted with brass caps, and a stop-cock (see Plate V.); I placed ten grains of the mercurial powder on very thin paper, laid an iron wire, 1/49th of an inch thick, across the paper, through the midst of the powder, and, closing the paper, tied it fast at both extremities, with silk, to the wire. As the inclosed powder was now attached to the middle of the wire, each end of which was connected with the brass caps, the packet of powder became, by this disposition, fixed in the centre of the globe. Such a charge of an electrical battery was then sent along the wire, as a preliminary experiment * had shewn me would, by making the wire red hot, inflame the powder. The glass globe withstood the explosion, and of course retained whatever gasses were generated; its interior was thinly coated with quicksilver, in a very divided state. A bent glass tube was now screwed to the stop-cock of the brass cap, which being introduced under a glass jar standing in the mercurial bath, the stop-cock was opened. Three cubical inches of air rushed out, and a fourth was set at liberty when the apparatus was removed to the water tub. The

* With Mr. Cuthbertson's electrometer.

explosion

explosion being repeated, and the air all received over water, the quantity did not vary. To avoid an error from change of temperature, the glass globe was, both before and after the explosion, immersed in water of the same temperature. It appears therefore, that the ten grains of powder produced four cubical inches only of air.

To continue the comparison between the mercurial powder and gunpowder, 10 grains of the best Dartford gunpowder were in a similar manner set fire to in the glass globe: it remained entire. The whole of the powder did not explode, for some compleat grains were to be observed adhering to the interior surface of the glass. Little need be said of the nature of the gasses generated during the combustion of gunpowder: they must have been, carbonic acid gas, sulphureous acid gas, nitrogen gas, and (according to Lavoisier *) perhaps hydrogen gas. As to the quantity of these, it is obvious that it could not be ascertained; because the two first were, at least in part, speedily absorbed by the alkali of the nitre, left pure after the decomposition of its nitric acid.

References to the Figures of the Glass Globe, &c. (See Plate V.)

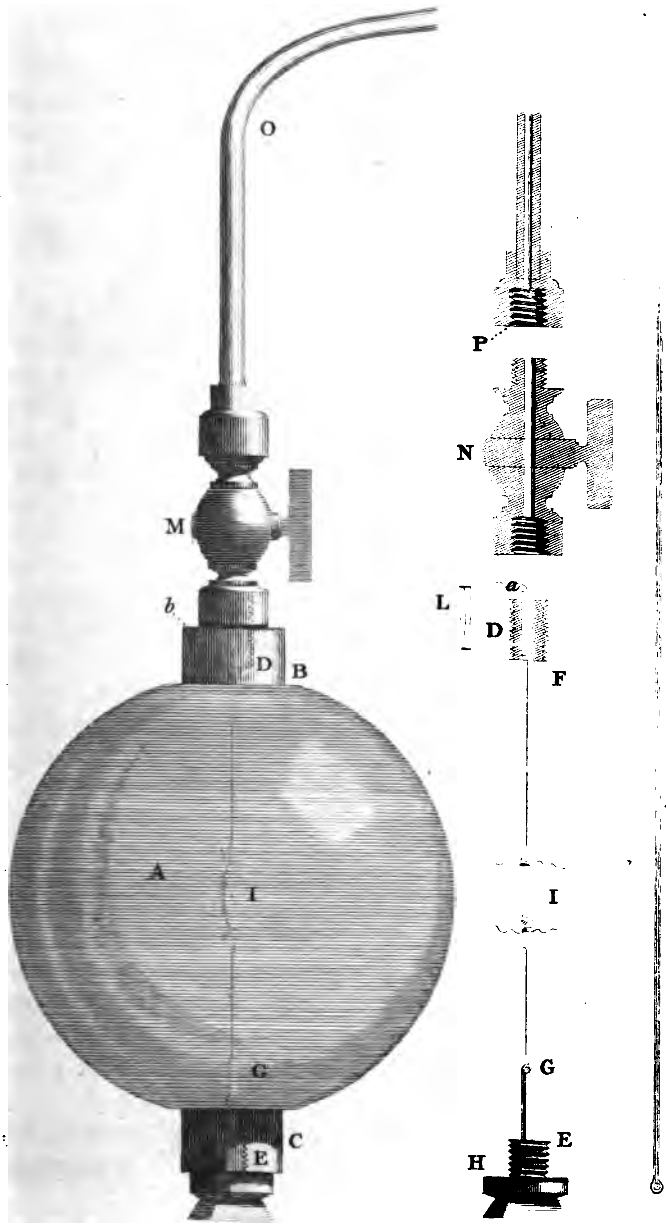
A, a ball or globe of glass, nearly half an inch thick, and seven inches in diameter. It has two necks, on which are cemented the brass caps B, C, each being perforated with a female screw, to receive the male ones D, E: through the for-

* See Lavoisier, Traité Elementaire, p. 527.

mer a ſmall hole is drilled; the latter is furniſhed with a perforated ſtud or ſhank G. By means of a leather collar H, the neck C can be air-tightly cloſed. When a portion of the powder is to be exploded, it muſt be placed on a piece of paper, and a ſmall wire laid acroſs the paper, through the midſt of the powder: the paper being then cloſed, is to be tied at each end to the wire, with a ſilken thread, as ſhewn at I. One end of this wire is to be faſtened to the end of the ſhank G, and the ſcrew D inſerted to half its length into the braſs cap B; the other end of the wire *a*, by means of the needle K, is to be drawn through the hole F. The ſcrew E being now fixed in its place, and the wire drawn tight, is to be ſecured by puſhing the irregular wooden plug L into the aperture of the ſcrew D, taking care to leave a paſſage for the air. The ſtop-cock M, the ſection of which is at N, is now to be ſcrewed on the part D, which is made air-tight by the leather collar *b*. The glaſs tube O is bent, that it may more conveniently be introduced under the receiver of a pneumatic apparatus. P, ſhews the manner of connecting the glaſs tube with the ſtop-cock.

TO BE CONTINUED IN OUR NEXT.

XVIII.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XVIII. *Memoir on the Preparation of Sugar of Lead, or the Acetite of Lead. By Citizen* MARCHAIS, *Member of the Lyceum of Arts, &c.*

Read before the *Société Académique des Sciences.*

SUGAR of lead, or as it is more appropriately termed by Chemists, the acetite of lead, is a salt necessary in various arts. It is chiefly used in dyeing, and almost the whole of what is consumed of it in France is imported from abroad. Are we then to conclude that foreign nations are better chemists than we? They have long possessed abundance of manufactories of chemical products, whilst we have had none till within these thirty or forty years, or at least, they were in so languishing a state, and so little productive, that they seemed to exist only in order to prove that France was not fit for this branch of industry; they were not even entitled to the appellation of manufactories of chemical products, as they confined themselves to the preparation of but a very few of those products; whilst in England, in Holland, and in Germany, there were a considerable number truly deserving of this name. The French chemists are, however, exempt from blame: this, a fact will prove better than argumentation. Formerly the Dutch almost exclusively furnished us with corrosive sublimate: their process had acquired a reputation of superiority, which time and the real beauty of the salt made it be believed, was impossible to be equalled; besides which, the careful exclusion of strangers from the manufactories, induced the opinion that

there were great difficulties to be ſurmounted; and nevertheleſs, the myſtery of the ſuperiority of the Dutch, conſiſted in their having become the monopolizers of all the mercury obtained from the mines of the Palatinate; thus, putting a price upon the re-ſelling of it, ſufficiently high to prevent all competition with thoſe of their manufactories in which this metal was uſed, they furniſhed them with it at as cheap a rate as poſſible. As to their chemical ſuperiority, it conſiſted in having read Lemery, this Father of the French Chemiſtry, who wrote at Paris 100 years ago, and in implicitly following the proceſs which he has deſcribed: hence all the multiplied precautions which they uſed in order to conceal the ſource from whence they derived their wealth. Time has revealed this anecdote, which is too little known, and which I thought it my duty to report, as it proves with what injuſtice the French have frequently ſuffered themſelves to be treated.

I do not wander from my ſubject, in offering theſe reflections, previous to giving an account of my experiments on the preparation of ſugar of lead. For a long time the Dutch have enjoyed a juſtly-acquired repution for the price and the beauty of this ſalt: France, however, poſſeſſes both lead and vinegar, the latter ſhe even poſſeſſes in abundance, and may poſſeſs it in ſtill greater abundance; with theſe circumſtances in her favour, whence proceeds this decided ſuperiority in favour of the foreign country? This is the queſtion which I wiſhed to reſolve.

I ſhould have commenced by examining what was the ſtate of our knowledge with reſpect to this manufacture: the authors who have treated of it, are very few in number, beſides which,

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they appear to have copied one another. Elementary treatises of chemistry cannot be expected to enter into the detail of manufactures; their silence upon the subject is therefore exempt from blame. The works relative to the arts reduce themselves to those of the *Academie des Sciences*, to the Dictionary of Chemistry in the *Encyclopedie Methodique*, and the Dictionary of Arts and Manufactures in the same Encyclopedia; the other authors either repeat them, or have used them as their sources of information; so that, except in those that I have named, nothing new or certain is to be met with; it is what they are defective in, which I wish to supply.

Machy, the only French author who has given circumstantial details concerning this manufacture, has represented it as being so difficult in the execution, that its success cannot always be certain. Those who have written since this author, have either added nothing to our knowledge, or have at least not been able to determine what was good in the antient processes, and what might be proper to be added to them; neither have they pointed out the grounds of the superiority of one process over the other, as they were unable to determine the theory of the operation in a clear manner, the evidence of which was supported by facts. Basil Valentin, and Isaac the Hollander, who are mentioned as the first who gave an account of the action of vinegar upon lead, and the salt thereby produced, required for that purpose much less science, and were obliged to make much fewer experiments than were afterwards required, in order to ascertain the uses of this salt in the arts, and especially in that of dyeing, in which it is of so great importance. At that time, in

in order to make chemichal discoveries, it was sufficient to place substances in contact, and see whether they exerted any operation upon each other. From thence to the knowledge of the theory of this action, the road was much longer than that which had led to the first observation; thus almost all the explanations which Chemistry gave of her operations, prior to the discoveries of the immortal Lavoisier, have rather retarded than accelerated the progress of the science. Every sound theory points out the route we are to take in a certain manner, but when the theory itself is erroneous, it leads us astray, and the arts receive no improvement. Local circumstances may render the error less perceptible, or cause it to disappear; but, when we do not well know what we are doing, which is almost as bad as not knowing it at all, we can never rectify our course, nor know whether or not it be the best which we could take, if perchance that should happen. What I have to say concerning the preparation of the sugar of lead is evident, is known, and yet it has never been said before, for the operation has remained obscure, uncertain, little productive in France, whilst other nations know how to derive profit from it: this is what must have happened, as the facts will prove.

It had been discovered that distilled vinegar was less concentrated than the same vinegar not distilled; because, in distillation more water raises itself than acid, the latter concentrating itself in the alembic; but this portion cannot be employed, as it is only after having been distilled, that it becomes proper for preparing the acetite of lead. My first idea was, to combine the oxyd of lead with vinegar not distilled, but, however,

however, without any colour, as I attributed to its extractive part, the impossibility of obtaining a crystalisable product from the direct combination of the oxyd and the acid. The preparation known in Pharmacy by the name of Extract of Lead, yields no crystals on condensation, but merely the appearance of an extract, such as is obtained from vegetables. I believed that I had found, in the oxygenated muriatic acid gas, a means of destroying the colouring matter of the vinegar. It was white wine vinegar that I used.

Experiment 1. The apparatus which I employed is a known one; it is that which chemists use for obtaining the muriatic acid gas, suspended in water; instead of water I had put vinegar into it: this lost its colour, and became very white. I ought to remark that it no longer retained its peculiar odour; neither had it that of oxygenated muriatic acid; but it had acquired one peculiar to this combination, which no author has hitherto treated of. Into 18 ounces, 5 drachms, 60 grains of this liquor, I put 3 ounces of the white oxyd of lead; of this there was a little that was not dissolved, and a small part precipitated in a pulverulent form; this was muriate of lead. The liquor poured off, subjected to a very slow evaporation, and cooled in its sand bath, presented nothing to the eye but a brown extract, having the smell of mucous-saccharine matter when beginning to burn, but no appearance of crystals was observed in it, after it had been kept cool for eight hours. I gently stirred it, inclining the vessel at the same time, in order to examine whether there might not be some crystals at the bottom; immediately the liquid was converted into a solid,

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and I had nothing more than a faline mafs, irregularly cryftalized and very brown. This was acetite of lead; but it ought to have been the acetite of commerce, with refpect to the whitenefs and regularity of the cryftals; it was only the chemift who could difcover in it the principles of the acetite of lead.

Experiment 2. I endeavoured to bleach the vinegar, if I may be allowed the expreffion, by the admixture of oxygenated muriatic acid diffolved in water; the vinegar was deprived of its colour, but the ftate in which I found it was precifely the fame as in the firft experiment; I therefore judged it fuperfluous to employ it for diffolving the white oxyd of lead, as I cou'l forefee the refult from the former experiment.

Experiment 3. Chemifts having frequently employed the fulphurous acid for depriving vegetable fubftances of their colour, I difpofed the apparatus ufed in experiment 1, and diftilled the fulphuric acid upon a combuftible fubftance (it was on ftraw); a confiderable difengagement of fulphurous acid took place; the vinegar became turbid, a very light precipitate was formed; but the colouring matter was not attacked: I therefore judged it ufelefs to treat the white oxyd of lead with this acid.

Experiment 4. I thought I ought to try, for the fake of comparifon, the folution of the white oxyd of lead in ftrong red vinegar. A pound of this acid was able to diffolve an ounce, and fome particles remained in the form of a brown powder. I tried in vain every expedient I could devife, in order to make this folution cryftalize. I had only a blackifh-brown extract, of the confiftence of honey, but which exhibited no appearance of cryftals,

cryſtals, diſtilled vinegar poured upon it very eaſily effected its complete ſolution; the ſolution was brown, and ſerved me for ſome experiments foriegn from the ſubject of this memoir.

The experiments which I have juſt related had taught me that if the colouring matter was an impediment to the cryſtalization, one ought not to attribute to it alone the more or leſs red appearance of the cryſtals of acetite of lead.

Experiment 5. I put ſeveral pounds of the ſame vinegar into a diſtilling apparatus of glaſs. I divided the whole into four portions in the following order: $\frac{1}{4}+\frac{1}{4}+\frac{1}{3}$, ſo that there remained only $\frac{1}{6}$ in the diſtillatory veſſel: the three firſt products preſented no apparent diverſity to the eye; they were equally limpid and colourleſs; the fourth was very high coloured, very acid, and when cooled depoſited cryſtals of tartarite of potaſh.

Experiment 6. Eight ounces of the firſt fourth were combined with 6 drachms 44 grains of white oxyd of lead *; the ſolution took place under a continued effervеſcence; the pieces of oxyd did not aſſume a brown colour, as in experiments 1 and 4; the ſalt which I obtained was beautiful, very white and brilliant; I had 5 ounces 36 grains of it; the mother-water was ſomewhat coloured, and yielded 70 grains of a reddiſh ſalt. The portions of the vinegar, No. 2 and 3, on being ſubjected to the ſame operation, yielded a ſalt much inferior to that of No. 1, eſpecially No. 3; the mother-water was in larger quantity and more coloured, as were alſo the cryſtals which were more irregular. The conſideration of theſe three

* To the quintal of vinegar, 10 lib. 5 oz. 2 dr. 16 grs. of oxyd, a little more than one-tenth.

facts gave me reason to conclude, that the oil, which exists in considerable quantity in vinegar, was the real cause of the difficulty which had been been found in obtaining the acetite of lead. Machy was not aware of this difficulty, though he was in the way to discover it; he relates that the manufacturers of Grenoble pour several ounces of alcohol into each of the vessels in which the crystalization is performed. What I have just said may serve to demonstrate the utility of this precaution. Alcohol has a decided affinity on the one hand with the acetite of lead, and on the other with the oil furnished by the vinegar; it will therefore dissolve in preference the oily and red crystals, or even the oily part, so that what remains in the vessel will be more beautiful, and freed from that substance which impaired its whiteness. Machy, and those who have repeated it after him, are wrong, in asserting that the manufacturers use this alcohol in order to prevent evaporation from taking place, during the crystalization of the salt: its direct object is to free it from that substance which would impair its whiteness. In order to demonstrate this theory with the most convincing evidence, it was necessary to take acetous acid that contained no oil, consequently not that which is obtained from wine; I therefore procured vinegar prepared from cyder.

Experiment 7. I distilled it in glass vessels, and twice stopped the distillation, in order to suffer the salt, which the liquor might contain, to crystalize; but not having perceived any crystalization, I continued it to exsiccation; a small quantity of extractive matter remained, which could be re-dissolved by water. I dissolved the white oxyd of lead in the distilled acid; the liquid remained

mained white and tranſparent, it cryſtalized completely, without any coloured mother-water, and the laſt cryſtals were no leſs beautiful than the firſt. Succeſs, ſo complete and conformable to theory, proved to me, that the real ſuperiority of the Dutch conſiſts in their employing in the manufacture of this ſalt vinegar exempt from oily particles, ſuch as are the vinegars prepared from grain. It is known that they manufacture theſe vinegars of very ſuperior quality, and that they very carefully keep ſecret the details of this operation. I have been informed upon good authority, that at the time when the Dutch territory was covered by our troops, and when the influence of France, in that country, was at its greateſt height, it was never poſſible to penetrate into theſe manufactories of vinegar, many of which even ceaſed for the time to work. The beautiful appearance of the ſugar of lead which they ſell us, depends therefore upon local circumſtances; they naturally would employ the acid which they manufacture themſelves, in preference to that for which they would have been obliged to procure the materials from abroad, as their ſoil produces no wine: our country, on the other hand, knows in general of no other vinegar than that produced from wine, which conſequently has been employed, and all theſe inconveniences have reſulted with which its uſe is naturally attended. It may perhaps be objected to me, that it is ſaid in the works that have been quoted, that the Dutch come to buy up the huſks of grapes in the Artois and Bordelois territories; myſterious as they are in whatever they undertake, if the Dutch pretend that the uſe for which theſe huſks are deſtined is the manufacture of ſugar of lead, I

 ſhould

the best indigo. It is termed *indigo-franc, indigofera anil.* It is indigenous in America; and is cultivated with succes in the Southern parts of this country, and in the Antilles. In these islands is found a variety of the best-species of indigo, which grows to twice the height of the indigo-franc. It is termed the wild indigo-plant or maron.

It is to be remarked, that in the French colonies in the Antilles, where fine indigo is prepared, the seed of the indigo-franc is purposely mixed with that of the indigo-maron, in order to obtain a more considerable and better product. The purposes for which this mixture is made, as well as all the operations belonging to the cultivation of the indigo-plant, are related in a detailed memoir that has been laid before the Lyceum of Arts. For the present we shall confine ourselves to giving an account of an essential improvement in the preparation of indigo.

It will undoubtedly be heard with astonishment, that though indigo has been manufactured during the space of nearly a century, its preparation still consists in such imperfect approximations, that, even with the best manufacturer, generally ten, fifteen, and even to the number of twenty-five tubs fail, out of a hundred which he undertakes. Sometimes even, either owing to want of experience or the contrarieties of temperature, a much larger number of tubs fail, and ruin the proprietor, who reckons upon large profits; hence in part arises the high price of indigo.

But should the proprietor of indigo-plants be secured, by means of a certain process, against the danger of losing the fruits of his expence and labour, he would then be able to sell his indigo

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at a cheaper rate. This would be a great advantage to the arts and manufactures, and consequently to the commerce of France.

This great advantage France will at ſome future period be able to enjoy, and ſhe will owe it to the labours and intelligence of one of the colonial proprietors of St. Domingo, who is at preſent in France, and one of the free aſſociates of the Lyceum of Arts, I mean citizen Nazon. Judicious obſervations and a long courſe of experience have convinced him that it is poſſible to enſure the ſucceſs of all the tubs of indigo.

In order to obtain this colouring ſubſtance, the indigo-plant is cut when it has arrived at its maturity. The whole is put to macerate in a baſin of brick-work, which is termed the tub *(cuve)*. Its dimenſions are generally twelve feet.

To bring the maceration to its ultimate point, requires from fifteen to thirty and even thirty-ſix hours, more or leſs, according to the temperature of the atmoſphere at the time when the operation is performed; it is alſo neceſſary to take into conſideration the quality of the indigo-plant, the nature of the ſoil that has produced it, and that of the water in which it is immerſed.

The firſt indication from which it is judged that the maceration begins to approach its ultimate point, is the ſinking of the ſcum, which elevates itſelf in the ſpace of about half a foot, which has been left empty in the tub, including the plants. When this ſcum has become a kind of cruſt of a copper-blue colour, the moment is concluded to be near at hand, at which the plants will be ſufficiently macerated. However this indication is inſufficient and often even fallacious. There is another upon which greater reliance is placed:

placed: it consists in drawing off a small quantity of the water by means of a cock placed at the lower part of the tub. It is received into a silver cup, and it is observed whether the fecula tends to precipitate itself to the bottom of the cup: when this is the case, it is concluded that the plants have attained that degree of maceration which is requisite for obtaining the indigo from them.

Such was the process most generally practised; but it too often gave rise to error. To avoid this we have a sure means, which consists in accurately observing the water contained in the cup: five or six minutes after it has been poured into it, it forms round the sides of the cup a ring or edge of fecula, which at first is of a green colour and afterwards becomes blue. As long as the maceration has not yet been carried to the proper pitch, this ring detaches itself with difficulty from the sides of the cup. But at last it is seen to precipitate and concentrate itself at the bottom of the vessel, always towards the centre, under the water, which has become limpid, though with a yellowish tinge.

When these appearances are observed, they infallibly indicate the success of this first operation. The water is then drawn off into a second basin or tub, placed beneath the first. This second tub is termed *batterie*, as its use is for beating the water still charged with the fecula. In order that it may separate quickly, it is agitated. This operation is performed either by the labour of the hands, or by means of a mill. It is of essential consequence not to agitate it for too great a length of time: excessive agitation mixes anew the fecula with the water, from which it does not separate any

any more, and the tub fails. Inſtead of indigo, we obtain nothing but muddy water.

This latter inconvenience may eaſily be obviated by a little attention. When we have diſcovered that the fecula is ſufficiently united, we draw off the water from the *batterie* into a third and ſmaller baſin, which is termed the *diablotin*. We then find the bottom of the *batterie* covered with a very liquid blue paſte; this is received into bags of coarſe linen cloth, of the form of inverted cones, which ſuffer the watery part to run off. Theſe bags are afterwards emptied of their contents upon tables in the drying rooms, where this blue paſte is kneaded, and after it has acquired a denſer conſiſtence, it is ſpread out and cut into ſmall ſquares, in order that it may dry the ſooner. The manufacture of the indigo is now completed, and it is ſoon after ſufficiently dry to be introduced into commerce.

I omit the details contained in a longer memoir, of which I confine myſelf to giving an extract. What was of importance to be made known, is that there exiſts a certain proceſs, by following which one may be ſecure againſt failure in the manufacture of indigo.

Experience has ſhewn that this proceſs has never failed of complete ſucceſs; of this, more than fifteen-hundred tubs of indigo manufactured in different parts of St. Domingo, have furniſhed the proofs.

XX. *Obſervations on Clarification.* By *Citizen* PARMENTIER.

FROM THE *ANNALES DE CHIMIE.*

THE term clarification is generally applied in pharmacy to an operation, by means of which liquids are freed from the foreign ſubſtances that impair their tranſparency.

This operation, ſimple as it may appear to be, nevertheleſs merits particular attention; eſpecially when we conſider the advantages which are obtained from it in the chemical and pharmaceutical arts. I therefore thought it might be uſeful to communicate ſome general obſervations on clarification.

It is not my intention, in this place, to diſcuſs the different methods employed for the proceſs of clarification, nor to enumerate in detail the reſpective effects which they produce upon the different ſubſtances to which they are applied; but I ſhall content myſelf with pointing out the principal phænomena that are obſerved in operations of this kind.

The end propoſed, when we wiſh to clarify a fluid, is to free it from ſubſtances, which, without being diſſolved, remain ſuſpended in it, and impair its tranſparency and limpidity; but theſe ſubſtances are ſeparated ſometimes by ſubſiding or filtration; ſometimes by the action of the air, of heat, of light, of motion, and of fermentation; ſometimes finally, by the aid of agents, which, in uniting the particles diſperſed in the liquid which we wiſh to clarify, often change their nature, and

and no longer permit them to remain in the ſtate in which they were before. We ſhall commence an inquiry with conſidering ſpontaneous clarification. This never takes place, unleſs when the particles, that are to be ſeparated, have a ſpecific gravity decidedly inferior or ſuperior to that of the fluid in which they are ſuſpended; they can then unite either at the lower part of the fluid or at its ſurface, and there form a maſs which may very eaſily be removed, if the ſeparation has been complete; the fluid then poſſeſſes all the tranſparency that can be deſired, and which the moſt accurate filtration cannot augment.

This mode of clarification is ſometimes ſubject to ſeveral inconveniences, the chief of which are, that it requires a conſiderable length of time to effectuate it, and that, during this interval, it contributes to favour the formation of new products, which, changing the compoſition of the fluid that was to be clarified, do not leave it the ſame as it was previous to its clarification, independent of the ſubſtances that impaired its tranſparency. We find a very ſtriking example of what happens in this caſe, when we conſider the circumſtances with which the ſpontaneous clarification of the juices of plants or fruits is attended. Theſe juices, when freſh expreſſed, are always turbid; they nevertheleſs become clear by imperceptible degrees; but then their nature is no longer altogether the ſame as it was before; for they contain products which would not have been found in them if they had been clarified immediately after having been expreſſed. Hence it alſo proceeds, that the juices of the lemon, the gooſeberry, the Seville orange, &c. when examined before or after their ſpontaneous clarifica-

tion, are ſo widely different with reſpect to their taſte, ſmell, colour, and economical properties.

In general, we may eſtabliſh it as a conſtant rule, that all the liquids ſuſceptible of fermentation are thoſe in which ſpontaneous fermentation produces the effects of which we have juſt been treating; whilſt theſe effects do not take place in thoſe which are little or not at all ſuſceptible of fermentation, and the tranſparency of which is impaired merely by particles which are incapable of exerting any operation upon the conſtituent parts of theſe liquids.

Thus, for example, water, alcohol, ether, oil, &c. when deprived of their perfect tranſparency, may eaſily acquire it again by ſpontaneous clarification, without the ſmalleſt change taking place in the compoſition of theſe fluids; for, if we examine them after they have been clarified, we ſhall find them ſimilar to others that have not been ſubjected to the proceſs of clarification.

The ſecond proceſs for clarifying fluids conſiſts in filtering them; but this operation can never be performed without the aid of intermediate ſubſtances, the very minute pores of which ſuffer only the fluid to paſs through them, but intercept the paſſage of all the particles that were merely ſuſpended in it.

An infinite variety of ſubſtances are uſed as inſtruments of filtration: paper, woollen, linen and cotton cloth, carded cotton, ſponge, ſand, earths, pounded glaſs, charcoal, porous ſtones, &c. all theſe ſubſtances may be uſefully employed in this operation; but their nature and purity ought to be examined, eſpecially when we have to filter ſaline ſubſtances.

It

It is the business of the chemical and pharmaceutical operator to choose, amongst the different kinds of filters, that which, whilst it is the best adapted for effecting the clarification of the fluids, is at the same time incapable of producing any change in its constituent principles. Now this choice is to be determined by the knowledge which we have of the nature of the fluid, and of the species of filter which it may be proper to employ.

If it be an aqueous, vinous, spirituous, or oily liquid, paper may be employed without any inconvenience, provided it be of a good quality. This last condition is to be strictly attended to, otherwise the product of the filtration will often be defective.

Paper is known to be a kind of web, formed of vegetable fibres, that have undergone various preparations. The particles of these fibres are intermingled in such a manner, as to leave between them pores, the tenuity of which is always proportionate to the state in which the paste was at the moment when it was converted into paper. If this tenuity be considerable, the pores are soon obstructed by the sediment which is deposited by the liquid we wish to filter; the filtration then ceases to take place. When, on the contrary, the pores are very wide, the filtration is effected rapidly, but always in an imperfect manner; for, whilst the liquid passes through the filter, it carries with it the more minute particles that were suspended in it, and only the grosser ones remain upon the surface of the filter.

The great art, therefore, is to choose paper, the pores of which have precisely the size requisite

for

for admitting only the fluid that is to be filtered, but none of the particles that impair its transparency.

We meet with two sorts of paper in commerce, which nearly produce this effect, and, though they are not always so perfect as might be desired, they are those which have hitherto been preferred. The one, which is semi white, bears the peculiar appellation of *papier Joseph*; the other is a kind of grey paper, but not so coarse as that which is used for wrapping different cheap articles of merchandize: both of them are manufactured without size.

The whiteness of the *papier Joseph* shews that it has been manufactured with a purer paste than that which has served for the manufacture of the grey paper; the liquids that have been filtered through it are always transparent; but it has the inconvenience of tearing very readily, and its pores are soon obstructed, so that the filtration goes on but slowly.

The grey paper can serve for a greater length of time to furnish also clear liquids; but, as the paste with which it has been manufactured has not been so well purified as that of the *papier Joseph*, it always communicates to the liquids a disagreeable taste, which proceeds from the solution of the foreign substances contained in this paper. This is also the reason why certain fluids, such as whey, wine, spirituous compounds, and other potable liquids, that have been filtered through grey paper, have always a smell and taste, which are easily recognised by experienced organs. Hence it proceeds, that, amongst these liquids, some are more susceptible of spoiling than when they have been filtered through the *papier Joseph*.

The

The nature of the paper demands our attention most of all when we have to filter saline solutions. If we have employed grey paper, it often happens, that a part of its substance is dissolved by their action, so that the filtered liquid is not so pure as we should wish to have it. This inconvenience, which is not equally perceptible when we use the *papier Joseph* in preference, may be still more diminished by the precaution of not employing filters till after they have previously been washed several times with boiling water. A careful preparer of medicines ought always to keep a store of filters washed in this manner, in order that he may be able to use them as occasion requires. *Josse*, a man of distinguished merit in pharmacy, to whom we are indebted for many important observations, has found their advantages in a variety of circumstances. He has remarked, amongst others, that whey, clarified and filtered through *papier raisin*, could be kept in good preservation for more than a fortnight, when filtered every day; which was not the case with the ordinary grey paper, though previously washed.

By a diametrically opposite effect, different vegetable juices have been kept transparent and in good preservation, without passing into the acid state, by filtering them every day through grey paper: it has only been observed, that their colour became more intense during the first days, and that they afterwards gradually became colourless.

But if the nature of filters demands our consideration, their form and position are no less deserving of our attention. In order that a filter of paper may produce its full effect, it is necessary that

that it ſhould not adhere at all points to the ſubſtance which ſupports it; otherwiſe the filtration would ſoon be interrupted. This inconvenience is avoided by folding it different ways; but as theſe folds ſoon become deranged, ſome prefer placing ſtraw, or glaſs tubes, between the filter and the ſupport. I confeſs that this latter expedient has not always ſucceeded with me, and that I have moſtly remarked, that the folds made in the filters produced as much effect as the ſtraw and tubes. In Germany, they uſe, for this purpoſe, funnels grooved on their inner ſurface.

A period arrives, at which, whatever precautions may have been taken, the filtration grows languid, and at length is entirely ſuſpended; this circumſtance takes place, when the pores of the paper are obſtructed in ſuch a manner as no longer to afford a paſſage to the fluid. Sometimes we may prolong the filtration, by giving a ſlight circular motion to the funnel; but this effect is of ſhort duration, and nothing more is left for us to do than to change the filter. It appears that no means has hitherto been diſcovered for remedying this inconvenience, to which all kinds of filters are liable.

It has been already obſerved, that filters of woollen cloth, linen, and carded cotton, are alſo in uſe; thoſe of woollen cloth were formerly very much in uſe; they are even the firſt that were employed; they were made in the form of a cone, the baſe of which was kept open by means of a ring, which was afterwards faſtened to a frame with ſtrings. This ſpecies of filter was termed the bag of Hippocrates; it is ſtill uſed for filtering ſpirituous compounds. As it may be made very capacious, it is able to receive a large quantity

quantity of liquid at once, but it paſſes through very ſlowly; often even it is neceſſary to wait for a long time before the liquid paſſes through clear, on which account one ought never to have recourſe to it, unleſs when others cannot be procured.

However, when ſyrups are to be filtered, woollen cloth is uſed; but then, inſtead of giving it the form of a bag, the cloth is merely fixed upon a ſquare frame, to which it is attached at its four corners by means of pegs. The boiling ſyrup is poured upon the middle of it, which almoſt always bags a little, and often at the end of a few minutes the liquor paſſes through very clear.

This filter thus diſpoſed may ſtill be employed for filtering many other liquids, eſpecially ſuch as are of a watery nature, and do not contain pot-aſh or ſoda in ſolution; for, were they never ſo ſlightly alkaline, the filter would ſoon be de-ſtroyed, and the filtered liquid would not poſſeſs the requiſite qualities.

Linen and paper are generally employed for filtering the alkaline liquids, and they anſwer the purpoſe very well, eſpecially when theſe liquids are not too much concentrated.

As to carded cotton, it is reſerved for filtering ſuch fluids as are conſidered precious, whether on account of the difficulty of procuring them, or of the ſmall quantity with which one is provided.

In order to form this filter, carded cotton is introduced into the tube of a glaſs funnel, and ſtuffed in with a rod of glaſs, ſo that it forms a kind of cork ſlightly compreſſed: the fluid which we wiſh to filter is then poured into the funnel. The filtration takes place drop by drop, and after the firſt have been ſeparated, thoſe which follow are always clear. The eſſential oils may very con-

 veniently

veniently be filtered by this means, without danger of waſte, which would inevitably take place if any of the other filters, of which I have already ſpoken, were uſed.

The acids, eſpecially thoſe that are in a concentrated ſtate, can only be filtered through pounded glaſs; but we muſt uſe the precaution not to employ this ſubſtance till after we have waſhed it ſeveral times, at firſt with a large quantity of water, and afterwards with an acid, in order to deprive it of the earthy or other foreign particles that might be diſſolved by the acids which we wiſh to filter.

TO BE CONCLUDED IN OUR NEXT.

XXI. *Obſervations concerning the Tin extracted from Bell-Metal, and the Fixity which Antimony acquires when it has been uſed as an Alloy for Tin.* *By* B. G. LE SAGE.

FROM THE *JOURNAL DE PHYSIQUE*.

IN order to ſeparate the copper from bell-metal, recourſe has been had to operations which ſcorify the tin, and a part of the copper. Metal was calcined in the reverberatory furnace; this oxyd was ſpread upon bell-metal kept in a ſtate of fuſion: the fire was kept up, the fuſed metal was run off, and pure copper was obtained in the proportion of 60 lbs. to the quintal of bell-metal; there remained blackiſh ſcoria intermixed with vitreous matter of a greeniſh colour. For want

want of means of reducing them, the scoria was abandoned to the purposes of mending roads and constructing dykes, as has been done at Romilly, near Rouen: however, the scoria contained still from 30 to 40 lbs. of tin and copper per quintal, as has been ascertained by the experiments of Citizen Anfry, a pupil of the first Academy of Mines, who has been able to turn them to such great advantage, that he has reproduced at least fifteen hundred thousand weight of tin, and two millions of pure copper.

This chemist reduces the scoria by fusing it with a pretty considerable quantity of charcoal: he obtains a metallic alloy with shining facettes, composed of copper, tin, and antimony; it is surmounted with an enamel of a greenish grey colour, which contains a quarter of its weight of tin. This metallic alloy he fuses in the reverberatory furnace, takes away every hour what is oxydated, which is in the form of a dirty white powder, and which he separates from the copper by lixiviation. There remains in the furnace an alloy of copper and tin, the fracture of which is not in facettes, but similar to that of the bell-metal.

The copper is separated from the tin by the process indicated in the preceding paragraph.

The calx, or oxyd of copper, of a dirty white colour, when it has been reduced by the charcoal, produces an alloy of tin and copper; its colour is yellow, like that of the pyrites of copper, and its fracture exhibits striated lamina, or crystals. This alloy, when in the state of fusion, is surmounted by a mixture of tin and the oxyd of this metal, which, when it has cooled, produces solid masses of a yellowish grey colour, the fracture

XXII. *List of Patents for Inventions, &c.*

(Continued from Page 72.)

JOHN WALKER, of Tufton-ſtreet, in the pariſh of St. John, Weſtminſter, Middleſex, Accoutrement-maker, and GODFREY ALPHY, of the ſame place, Painter; for a method of making and manufacturing men's hats and caps, and rendering them perfectly water-proof; as alſo all kinds of leather, cotton, linen, ſilk, ſtuffs, paſteboard, and other manufactures and ſubſtances, for the purpoſe of being worked up into ſhoes, boots, women's hats and bonnets, and other wearing apparel, and to be uſed on all occaſions where a power of repelling wet or moiſture may be required. Dated November 3, 1801.

WILLIAM JACKSON, of Eaſingwould, Yorkſhire, Gentleman; for a machine or drill to be fixed to a plough-beam for drilling or ſowing turnips. Dated November 3, 1801.

DAVID STEWART, of Woodlands, in the pariſh of Greenwich, Kent, Gardener; for a method of ventilating dwelling-houſes, theatres, hoſpitals, and other buildings; and alſo of ventilating, heating, and conſtructing, of every kind of buildings for forwarding or preſerving trees, plants, ſhrubs, flowers, fruits, roots, and vegetables, on an improved principle; thereby reducing the conſumption of fuel, ſimplifying the mode of management, and rendering more certain the production of fruit and flowers. Dated November 3, 1801.

FRANCIS

FRANCIS BREWIN, of Bermondſey, Surrey, Tanner; for a new and improved method of tanning. Dated November 3, 1801.

JOHN CONRAD BECKER, of Princes-ſtreet, Soho, Middleſex, Muſical Inſtrument-maker; for improvements in muſical inſtruments, chiefly applicable to harps and piano-fortes. Dated November 7, 1801.

ANTONIUS BEMETZRIEDER, of Chelſea, Middleſex, Maſter of Arts, and ROBERT SCOTT, JOHN SCOTT, and ALEXANDER SCOTT, of Margaret-ſtreet, Cavendiſh-ſquare, Middleſex, Muſical Inſtrument-makers; for a method of making piano-fortes, entirely new, both in principle, conſtruction, and ſhape. Dated November 10, 1801.

ARCHIBALD THOMPSON, of Three Kings-court, Lombart-ſtreet, in the city of London, Engineer; for machinery for the purpoſe of ſpinning rope-yarn or ſail-cloth-yarn, and for laying or making ropes and other cordage. Dated November 10, 1801.

STEPHEN HOOPER, of Walworth, in the pariſh of St. Mary, Newington, Surrey, Gentleman; for machines or machinery for the purpoſe of cleanſing harbours, rivers, &c. Dated November 10, 1801.

WILLIAM ROBINSON, of Eſſex-ſtreet, in the pariſh of St. Clement Danes, Middleſex, Peruke-maker; for a method of making perukes and ſcalps. Dated November 10, 1801.

JOHN STEVENSON, of Mancheſter, Lancaſhire, Tobacconiſt; for a method of ſtoving and drying tobacco, and the preparation of ſnuffs. Dated November 10, 1801.

ROBERT DICKINSON, of Long Acre, Middleſex, Gentleman; for improvements in the conſtruction

struction of, and additions to, the saddles, harness, and other gear, necessary or useful for the employ of horses and other animals. Dated November 10, 1801.

Isaac Sanford, late of Hartford, in North America, Gentleman, but at present residing in the parish of St. Pancras, Middlesex; for a machine for cropping or shearing of woollen, cotton, linen, silk, and all other cloths made with a nap, that require to be cropped or sheared. Dated November 14, 1801.

Chester Gould, of Red Lion-street, Clerkenwell, Middlesex, Merchant; for an apparatus or artificial horizon, to be attached to, and used with, the quadrant or sextant, for the purpose of taking the altitudes of celestial and other objects, either on land or water, without the assistance of the natural horizon. Dated November 17, 1801.

Joseph Bramah, of Pimlico, Middlesex, Engineer; for improvements in the construction of steam-engines and boilers, and for the purpose of generating steam, and other purposes. Dated November 28, 1801.

George Hall, of the Strand, Middlesex, Goldsmith; for a method of making elastic fastenings for shoes, &c. Dated November 28, 1801.

Edward Ryley, of the lordship of Myton, in the county of the town of Kingston-upon-Hull, Organ-builder and Piano-forte-maker; for moveable keys for piano-fortes, organs, and other instruments. Dated November 28, 1801.

Printed by Nichols and Son, Red-Lion-Passage, Fleet-Street, London.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XCIII.

Printed by NICHOLS and SON, Red-Lion-Passage, Fleet-Street.

XXIII. *Specification of the Patent granted to Mr.* JOSIAH LONGMORE, *of Birmingham, in the County of Warwick, Gun-lock-maker; for a Patten or Clog.* Dated June 2, 1801.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Josiah Longmore do hereby describe and ascertain the nature of my said invention, and in what manner the same is to be performed, as follows; that is to say: By means of an elastic tongue or spring, made of iron, or any other metallic substance, through a perforated hole, or otherwise, in the middle of the block of the patten, to press against the sole of the foot, thereby keeping it tight against the ties. The foot or block to be made of iron, wood, cork, or any other substance proper for the occasion, or of any two or more such substances united. In witness whereof, &c.

We are requested to add, that the Patentee hath assigned all his interest in the above letters patent to John Baynham and Jacob Pope, of Birmingham, Factors and Co-partners.

XXIV. *Specification of the Patent granted to Mr.* JOHN CONRAD BECKER, *of Princes-street, Soho, in the County of Middlesex, Musical Instrument-maker; for Improvements in Musical Instruments, chiefly applicable to Harps and Piano Fortes.* Dated November 7, 1801.

WITH A PLATE.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Conrad Becker do hereby declare that my said invention consists in the following improvements in the harp and piano forte. Of the harp, as follows; that is to say: I produce the sharps, flats, quarter notes, or any intermediate variation deviating from the natural notes, by causing (what are commonly called) the wrest pins, I mean the pins by which the strings are extended and tuned, to move partly round their centres, and thereby increase or decrease the tension of the strings, more or less, as may be required, to answer the desired change of the notes. To this purpose the said wrest pins are connected with the pedals by an apparatus hereby described, and more clearly expressed, by the annexed drawing (see Plate VI.) Fig. 1, *a a*, represents the wrest pin passing through a socket *b*, with a lever *c c*, on which slides a quadrant *d*; on this quadrant are fixed the links *e*, *e*, kept stationary by a regulating screw *f*. These links communicate with the pedals by the interposition of a crank *g*, Fig. 2, where are seen all the quadrants *d*, with levers and wrest pins belonging to their respective strings

ſtrings of the ſame denomination. On the ſaid crank *g* is alſo a regulating ſcrew *f*, to adjuſt the whole to the motion of the pedals. Now if any one of the pedals is preſſed down, all its appertaining quadrants with the wreſt pins muſt follow, and conſequently the tenſion of the appending ſtrings will be increaſed accordingly; and as ſoon as the pedal is left at liberty, the ſtrings will, by their reaction, reſume their former degree of tenſion, and the pedal its former ſtation; hence it follows, that a variety of changes may be effected on each ſtring throughout the inſtrument by the motion of the pedals. It is obvious that to this end the quadrants and the parts of the wreſt pins, round which the ſtrings coil, muſt, in regard to their circumferences, be ſo proportioned that by the motion of the pedals each ſtring ſhall have its tenſion altered uniformly with the reſt of the ſtrings belonging to the ſame pedals, ſo as to keep in tune together. If in caſe new ſtrings are put on, perhaps differing in ſize or quality, any irregularity ſhould take place, this muſt be corrected by the regulating ſcrew *f*; for if by this ſcrew the quadrant is moved towards or from the centre of the wreſt pin, its motion will be accordingly more or leſs. To ſtop the pedals at four different ſtations, anſwering to the natural note, to one quarter, to one half, and to three quarter notes, I apply a kind of rack, as ſeen in Fig. 5. *a*, *b*, *c*, are the ſteps, which being ſo diſpoſed preſerve the pedal in each ſituation in a perpendicular line, and thereby prevent them coming too cloſe to one another. To eaſe the motion of the pedals, having each of them ſix or ſeven ſtrings to act upon, I apply a ſpring to each pedal, to counteract the tenſion of the

 ſtrings,

ſtrings, and thereby render the motion of the pedals as eaſy as I pleaſe. As in tuning the harp it is generally attended with difficulty to find out the wreſt pin belonging to its reſpective ſtring in the baſs, particularly for ſhort perſons, I reverſe the wreſt pin, and form the ſquare for the key, by which the inſtrument is tuned at the ſame end where the ſtring is applied, as Fig. 3. To facilitate the tuning of this inſtrument, I have ſtill another contrivance, *viz.* inſtead of turning round the wreſt pin in its ſocket, in which it muſt move tight, to be capable of ſuſtaining the ſtreſs of the ſtring, I fix it into the ſocket, and to receive the ſtring I apply a ſeparate piece *k*, Fig. 4, with a notched rim, to be turned by an endleſs ſcrew *f f*, which is ſupported by a collar firmly fixed to the pin. When the former method is made uſe of, it will be neceſſary to apply a ſet of ſprings, as ſhewn at Fig. 2, to ſupport the levers *c*, belonging to the ſmaller ſtrings, in the act of tuning, in their proper poſition; for as the wreſt pin in drawing up the ſtring moves in the ſame direction as it is propelled by the pedals, the lever will be carried along with it if nothing is put in oppoſition to overcome the friction which ſubſiſts between the wreſt pin and ſocket. This friction may be adjuſted by the ſocket *b*, Fig. 1, being ſlit at *h*, and an adjuſting ſcrew *i* introduced; beſides this, a lining of leather or any other elaſtic ſubſtance within the ſocket may be of ſome ſervice. Inſtead of the ſpring *s*, Fig. 2, ſeveral other mechanical contrivances may be made to anſwer the ſame end.

In piano fortes, or other ſtringed inſtruments, played with keys, I uſe one or more wheels, to cauſe

cause the ſtrings to vibrate. Theſe wheels are placed under or above the ſtrings, and put in motion with a pedal or pedals, or any other mechanical power, and the ſtrings are by the touch of keys inclined to the wheels. In the manner of extending and inclining the ſtrings conſiſts the principle of my invention. In the diagram, Fig. 6, *a*, repreſents the ſtring faſtened by a loop and pin at *b*, and extended by a moveable lever or brace, with two points or knife-edges reſting againſt two props at *c*, *c*: here it may be eaſily conceived that if the ſtring paſſes through the direction of the points of motion *c*, *c*, of the lever, the ſtring has no inclination to either ſide, but may, without materially altering its tenſion, be moved up or down a little way by *d*, and very little power will keep it in due bounds. The gravity of the lever, connected with a key, will be ſufficient to keep in balance with the ſtring when its direction is a little above thoſe points of motion; hence it is eaſy to conſtruct an inſtrument on this principle ſo as to make the keys with the ſtrings move a little way up and down very freely. Secondly, if the ſaid lever on its extremity inſtead of two points or knife-edges forms part of a circle, the radius of which is the length of the lever, and reſts againſt two circular ſurfaces, deſcribed by the part of the ſtring *c* to *b*, Fig. 7: here it is evident, that by moving the lever at *d* up to *m*, or down to *n*, the tenſion of the ſtring will not in the leaſt be altered, and yet yield to the ſlighteſt touch. The application of this principle is not confined to theſe two inſtances, but will admit of a variety of forms and applications. If therefore the ſtring be any-wiſe extended on any thing moveable, having its prop or fulcrum any where within the extent

extent of the ſtring, or its two ends higher or lower, for the purpoſe of inclining or moving the ſtring to the wheels, or altering the tenſion of the ſtrings to raiſe or lower the tone thereof, it will compriſe the principle of my invention. Where hammers and dampers are uſed, I mean to connect both, ſo as to conſtitute one piece by letting one or two ſlips, of any convenient material, paſs through between the ſtrings, which are to be faſtened to the hammer below the ſtrings, and likewiſe to the dampers above them; by that means the mechaniſm will be ſimplified, and their gravity is thereby united, and ſerves each alternately. The hammer may move on a hinge in any of the uſual ways, or otherwiſe, and the damper form part of the ſaid hammer. In witneſs whereof, &c.

The Patentee deſires to inform the public, that by the above ſimple contrivances, the pedal-harp is rendered the moſt perfect of any muſical inſtrument whatever; for on it the ſkilfull muſician has it in his power to raiſe and depreſs each note at pleaſure, and thereby modulate and introduce graces beyond the limits of compoſition; an object which has long been axiouſly deſired by the firſt profeſſors of that inſtrument; but all former attempts have failed of ſucceſs.

The inventor therefore is induced to flatter himſelf, that he ſhall experience the kind patronage of the profeſſors and lovers of muſic in general; particularly as, by his peculiar methods and machineries for manufacturing the ſaid inſtruments, he is enabled to make them more durable

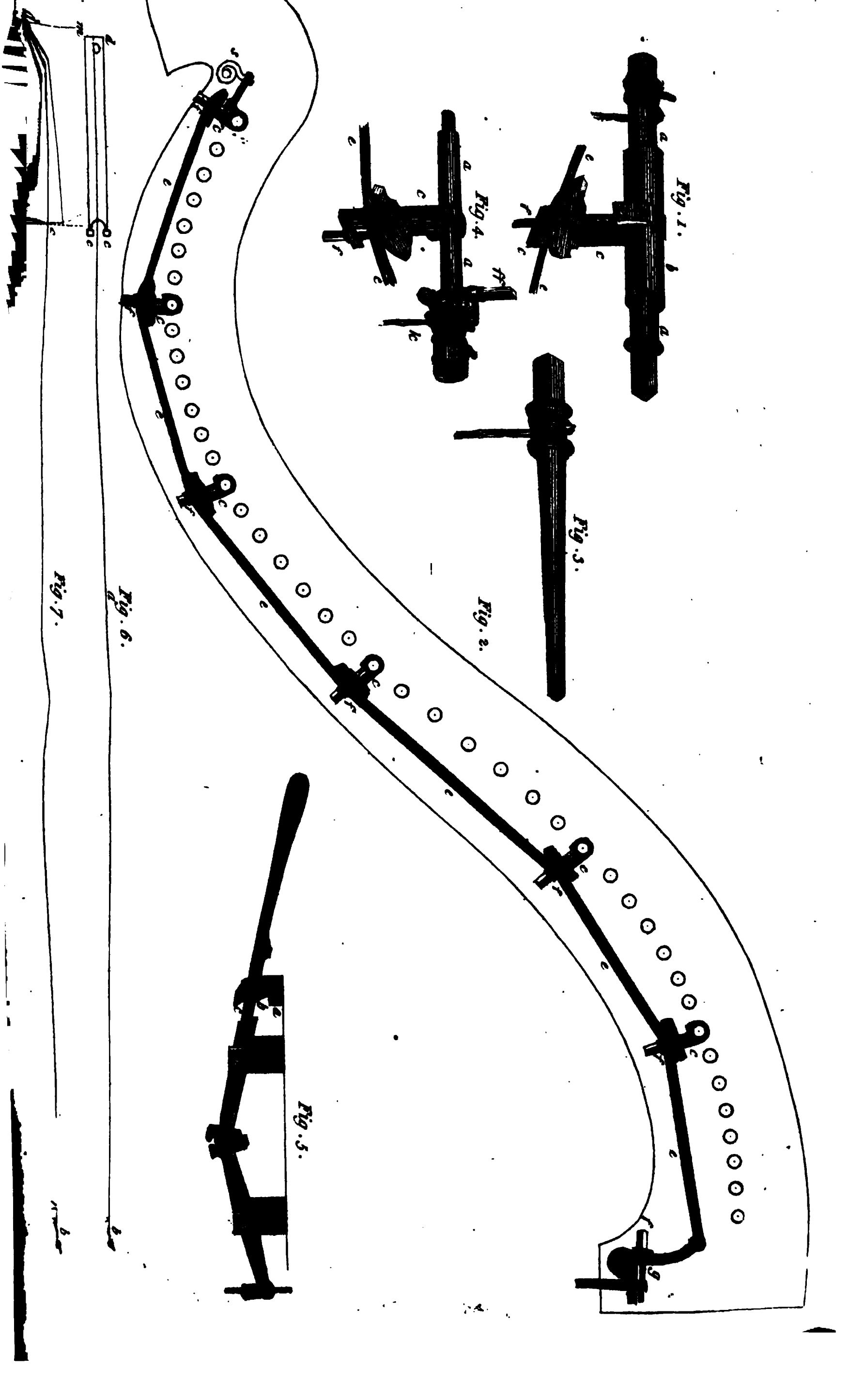


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.

able in their mechanical parts, and at an expence not exceeding that of the common kind.

The inventor at the same time begs leave to inform the public, that his manufactory will be established at No. 5, Leicester-street, Leicester-square, in the middle of the month of March next.

XXV. *Specification of the Patent granted to Mr.* JOSEPH TIDMARSH, *of Elizabeth-street, Hans-Place, in the Parish of St. Luke, Chelsea, in the County of Middlesex, Glazier and Painter; for an Article which may be used alone as a Substitute for Paint, or mixed with Paints in general, for the Purpose of enlarging their Quantity, and reducing their Price.* Dated February 28, 1799.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said Joseph Tidmarsh do hereby declare that my said invention or discovery is described in manner following; that is to say: This article or ingredient is made by pulverizing the following articles, *viz.* glass of every description, burnt or baked clay, including every kind of earthen or stone wares, the slag from manufactories of glass, copper, brass, iron, &c. also marble, spars, flints, or other calcareous or vitrifying earths or compositions made therewith. The powders of the articles specified above may be used as paint with all liquids that are applied to mixing of paints, or may be mixed immediately with paints of every kind. In witness whereof, &c.

XXVI.

XXVI. *Specification of the Patent granted to* William Bolton, *Esquire, Captain in the Royal Navy; for an improved Rudder, and the Means of preserving the Rudder.*

Dated June 23, 1801.

WITH A PLATE.

TO all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said William Bolton do hereby declare, that my said invention is described by the drawings and explanation thereof hereunto annexed. (See Plate VII.) In witness whereof, &c.

My invention consists in fixing the rudder, so that when the vessel touches the ground, &c. it will rise of itself, or it may be lifted at will by any of the ordinary mechanical powers, as screws, lever, tooth and pinion, &c. This invention is carried into effect by hanging the rudder on a metal bar, bolt, or slide; passes through the braces, or a solid frame fixed to the stern-post; and those braces on the aft side are made to correspond to the bar, bolt, or slide. In the annexed drawing, Fig. 1, A, rudder; B, bar, bolt, or slide, to which the rudder is hung; C, braces corresponding to B, and which confine it to the stern-post; D, stern-post; E, screw-bolt, passes through the head of B, (which is tapped,) by turning the lever *d*, raises the rudder; F, iron tiller, which spans the rudder-head, and through which the rudder and B slide when lifting. *a*, pintles; *b*, googings, cast solid with B. My improved rudder consists of the means of enlarging its size whenever it may be necessary. The rudder is slit down,

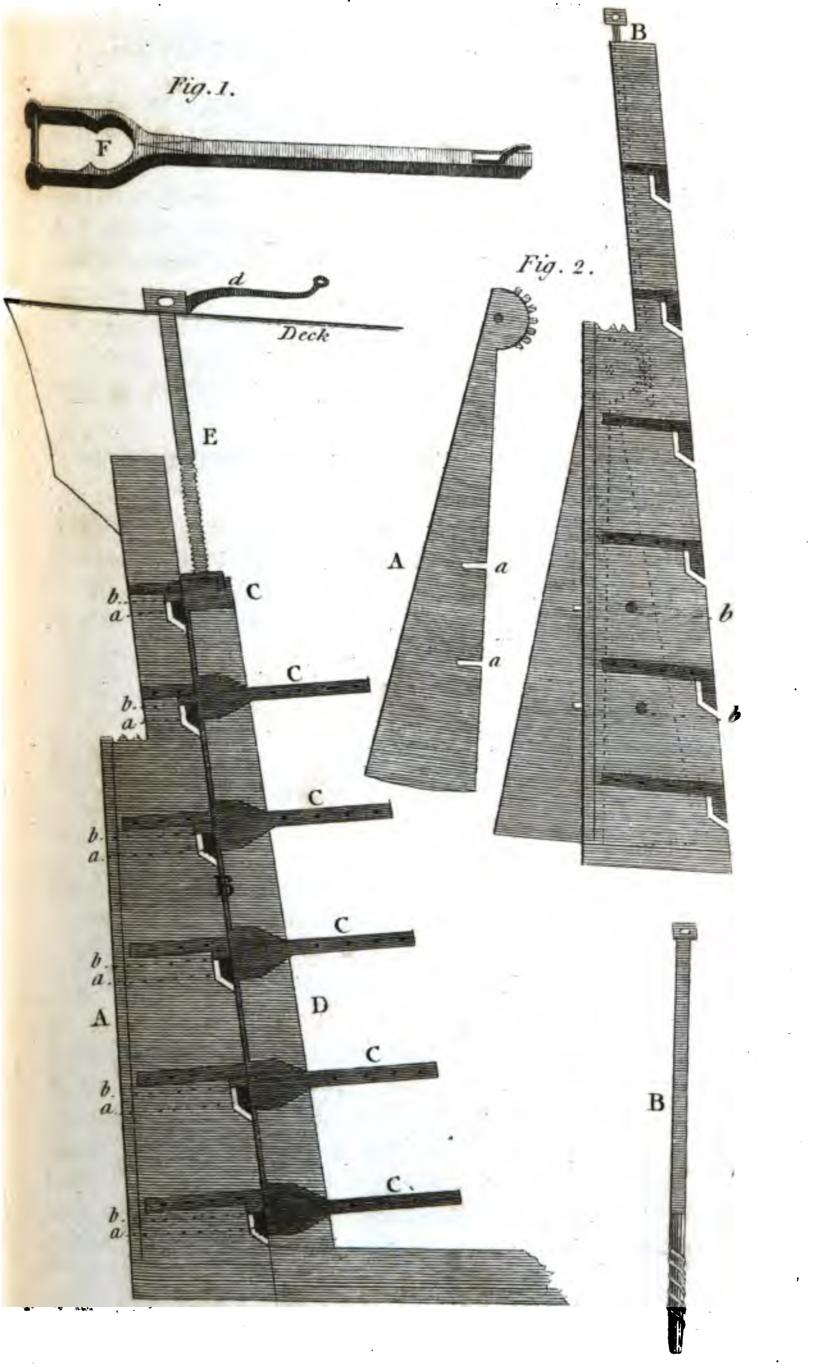


Fig. 1.
F
Fig. 2.
d
Deck
E
B
A
a
a
b
b
C
C
C
C
C
C
b.
a
b.
a
b.
a.
b.
a.
b.
a.
b.
a
A
D
B

down, or it may be made in two parts, in which is inserted a piece of wood, or metal plate, similar to A, Fig. 2, the upper end of which is circular, and furnished with teeth, and turns on its centre. A bolt B passes through or at the back of the rudder, and either throws out or draws in A, by turning to the right or left. In order to strengthen the rudder, either screw or shoulder-bolts, as *b*, *b*, may be fitted; and grooves, as *a*, *a*, will traverse over them.

XXVII. *Account of the Under-ground inclined Plane, executed at Walkden Moor, in Lancashire, by his Grace the Duke of* BRIDGEWATER. *By the Rev.* FRANCIS H. EGERTON, *of Bridgewater-house.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Gold Medal was voted to his Grace as a Testimony of the high Opinion entertained by the Society of his Grace's Execution of this great Work, and of his wonderful Exertions in Inland Navigation.

I BEG leave to present to the Society an account of the Under-ground inclined Plane, which the Duke of Bridgewater has lately made at Walkden-Moor, between Worsley and Bolton, in Lancashire. To this account I have subjoined two plans, with a table of reference to each.

At Worſley the Duke of Bridgewater's navigation begins; it goes weſt to Leigh, and eaſt to Mancheſter, where it locks up into the Rochdale canal. In its way to Mancheſter, it turns out, in a weſtern direction, near Longford Bridge, to meet the Grand Trunk Canal, above Preſton Brook; and from thence it goes north-weſt to Runcorn, where it locks down into the Merſey, in the tide-way to Liverpool.

To this navigation above-ground, which, in all its directions, is extended through a length of * forty miles, upon one level, without tunnel or lock, except the locks at the extremities. At Worſley, an under-ground navigation is joined, which goes to the different mines of coal under Walkden-Moor; from which mines, by theſe navigations above-ground and under-ground, Mancheſter and various other places are ſupplied with that valuable article.

The canals of this under-ground navigation lie upon two levels, or ſtories.

The lower is upon the ſame level with the open navigation, which it joins at Worſley; and conſiſts, in the different lines which it purſues to the different ſeams of coals, of near twelve miles of tunnelling.

* Adding to theſe forty miles, nearly twelve miles of the Duke of Bridgewater's Under-ground Navigable Canal, which lie upon his lower main level, and including eighteen miles of the Grand Trunk Canal betwixt the loweſt lock between Middlewich and Preſton Brook, there are ſeventy miles of navigable canal, without a lock, upon one level, eighty-two feet above low-water mark; whereby a communication is obtained between London, Liverpool, Briſtol, and Hull. At this loweſt lock the Grand Trunk Navigation locks down, to be upon a level with the Duke of Bridgewater's.

The

The higher is thirty-five yards and a half perpendicular height above the level of the lower, and varies from thirty-eight to ſixty-one perpendicular yards below the ſurface of the earth, and conſiſts of near ſix miles of tunnelling.

The tunnelling of each level is ten feet four inches wide, and eight feet ſix inches deep; and the depth of water, three feet ſeven inches.

Before a communication was made by an inclined plane, the coals were diſcharged by hand from the boats on the higher level, and were let down the pits in tubs by an engine and a break-wheel into thoſe upon the lower. To convey the boats themſelves from the canals of the higher level into that of the lower, was the intent of making this under-ground inclined plane. By the help of this machinery, the whole buſineſs is now done at once, without diſcharging or damaging the coal, and at one-fourth of the expence: for the boats of the higher level are bodily let down the inclined plane, and are floated from the foot of it through nearly three miles, in a ſtrait line, of the lower level canal, into the open navigation at Worſley: and, whereas they were before obliged to be drawn up to the ſurface of the earth at great inconvenience and expence, to be repaired at a work-ſhop on Walkden-Moor, they now come of themſelves, in their courſe of buſineſs, to be repaired at the great dock-yard at Worſley.

The place where the inclined plane is conſtructed, is adapted in a ſingular way for the purpoſe. There is a bed of white rock, or grit, eight yards twelve inches deep, which dips one in four, lying exactly in the direction moſt convenient for the communication between the two

levels; which bed of rock is hollowed into a tunnel, driven upon the riſe of the metals, by blaſting with gunpowder, and working it down with wedges and hammers. In this tunnel, formed through a rock reaching from the lower to the higher level, the inclined plane is fixed; and, by its being in the heart of a rock, the whole workmanſhip can be pinned, ſecured, and compacted together at the top, bottom, and ſides, moſt effectually:—an advantage which no inclined plane above-ground can have, and which renders this a ſingular production, no where perhaps to be imitated.

The run of the inclined plane is one hundred and fifty-one yards, beſides eighteen yards, the length of the locks, at the north or upper-end: and the fall is one in four, correſponding with the dip of the rock.

Of theſe one hundred and fifty-one yards, about ninety-four yards are formed into a double waggon-way, in order to let two boats, namely, the empty and the loaded boats, paſs up and down; and are divided by a brick wall, ſupporting the roof, in which are openings for a perſon to eſcape out of the way of the boats; which double waggon-way joins in one, about fifty-ſeven yards from the lower level.

The whole width of the double waggon-way is nineteen feet; and of the ſingle waggon-way, after the junction, ten feet.

Theſe waggon-ways are ſupplied with iron rails, or gullies, laid on ſleepers, down the whole run; and the height of the roof, above the iron rails, is eight feet.

At the top of the inclined plane there is a double lock, or rather two locks, ſide by ſide, formed in the heart of the ſame rock, which deliver

liver the loaded boats from the higher level down the inclined plane, and receive the empty boats from the lower. The length of that part of the tunnel in which these are formed, is eighteen yards; the width or diameter, twenty feet six inches; and the height of the roof, at the north end and above the locks, at *d d*, Plate VIII. Fig. 1, twenty-one feet, to admit the break-wheel.

The bottom, or south end of the inclined plane, is six feet nine inches under the surface of the water, where the loaded boat floats off the carriage upon the canal of the lower level.

The depth of the locks, under water, at the north end, is four feet six inches; at the south end it is eight feet.

The wall between the locks is nine inches above the surface of the level water; its breadth is three feet.

The diameter of the horizontal main-shaft, upon which the rope works to let the loaded boats down, and to draw the empty boats up, is four feet eleven inches, and its circumference is fifteen feet five inches. The main-rope is two inches and a half in diameter, and seven inches and a half in circumference. It is lapped round with a small cord of about an inch in circumference, for the length of about one hundred and five yards, to prevent its wearing, which it does chiefly when it drags upon the bottom, when at work, at the place where the waggon-ways unite; and, for the same purpose, rollers of eight inches diameter are fixed at intervals down the run of the inclined plane. Moreover, a hollow cast-iron roller of eight inches and a half diameter is fixed across the west lock, parallel to the upper west lock-gate, and near the north end of the lock, but half a yard

yard higher than the gate, in order to bear up the rope, and to prevent it from ſwagging.

A hold-faſt rope is faſtened to the main-rope, to ſtay each boat upon its waggon, as they go up or down. It is marked *k k*, in Fig. 1, and its uſes are more particularly detailed in the table of reference, at *k k*, to that plate.

Upon this horizontal main-ſhaft is a break-wheel above-mentioned, which regulates the motion of the loaded boat going down the inclined plane.

The number of iron teeth, or cogs, in the ſpur-wheel, which is faſtened to the ſide of the break-wheel, is three hundred and ſeventy-two: and the little nut-wheel, No. 3, Fig. 2, which ſets it in motion, contains eleven teeth, or cogs. The nut-wheel is ſupported by two uprights from the pillar to the roof, and works between them. Two winches or handles, No. 4 4, Fig. 2, on its axis, put the main-ſhaft, *d d*, Fig. 1, or No. 1, Fig. 2. in motion. The power of both united enables a man, who uſes a force equal to forty pounds weight, to ſet forward two tons upon the waggon-road: and this force, multiplied at the winches or handles, may be uſed to ſet forward the loaded boat out of one lock, and to bring the empty boat into the other. The boats being thus put in motion, the little nut-wheel is diſengaged from the main-ſhaft, by a ſlide drawing the little nut ſideways, ſo as to diſengage the teeth, or cogs, from the cogs of the ſpur-wheel. The weight of four tons going down bring up about one.

The ſpur-wheel, however, which is faſtened to the break-wheel, No 2, Fig. 2, is ſeldom uſed, as it is occaſionally only put in motion to regulate the

the ſtretch of the ropes when new, and to draw the light boat into the lock, when, at any time, it may happen to be over-weighted with materials, ſuch as mortar, props, ſlabs, &c. for the uſe of the higher level collieries, and will not move of itſelf, upon a balance, out of the lower level.

The length of the carriage, or cradle, is thirty feet; its width is ſeven feet four inches. It moves upon four ſolid caſt-iron rollers, which run upon caſt-iron plates; on one ſide of each of which there are iron creſts, which ſtand two inches higher than the plates, and prevent the carriage from running off the road.

The weight of neat coal, contained in the loaded boat, is about twelve tons: the boat weighs about four tons; and the carriage, or cradle, in which the boat is placed, when conveyed down the inclined plane, is about five tons: —in all about twenty-one tons.

At this inclined plane thirty loaded boats are now let down with eaſe, in about eight hours; that is to ſay, four boats are let down in a little more than an hour. The boats uſed in theſe collieries are of different ſizes and dimenſions; ſome will carry ſeven, ſome eight and a half, ſome twelve tons.

The weight of neat coal, independently of the weight of the carriage and boats which is let down the inclined plane, in twelve-ton boats, in eight hours, will conſequently be three hundred and ſixty tons. The weight of the carriage, ſuppoſe five tons, let down in the ſame time, will be one hundred and fifty tons; and the weight of the boat, ſuppoſe four tons, thirty times down, in eight hours, will be one hundred and twenty tons:

tons:—in all six hundred and thirty tons down in eight hours.

The weight of the carriage thirty times up, and thirty boats up, in eight hours, will be

Carriage,	at 5 tons,	30 times up	= 150 tons
Boat,	at 4 tons,	30 times up	= 120 tons
		In all	270 tons up in eight hours.

So that there will be 630 tons down
270 tons up

In all 900 tons moved at the inclined plane, in 8 hours, exclusive of an indeterminate quantity of materials occasionally brought up for the use of the higher level collieries.

The various feeders which are loosened by opening the coals in the higher level collieries, as well as three sufficient reservoirs, which may occasionally be resorted to, and used in a dry season, keep the higher level always to its height, and afford a constant supply of water to fill the locks, for the purpose of working the inclined plane.

This inclined plane was begun in September, 1795; it was finished, and in use, in October, 1797.

Of this, as of most of his other great works, the Duke of Bridgewater was himself the planner and contriver:—to project greatly, and to execute completely, are the perfection of genius.

The

Fig. 3.

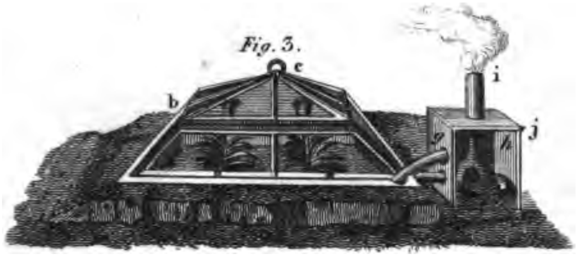


Fig 4.

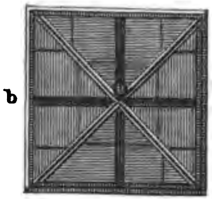
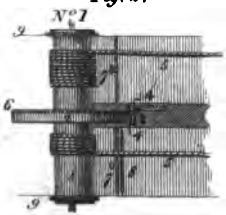


Fig 5.

Fig. 2.



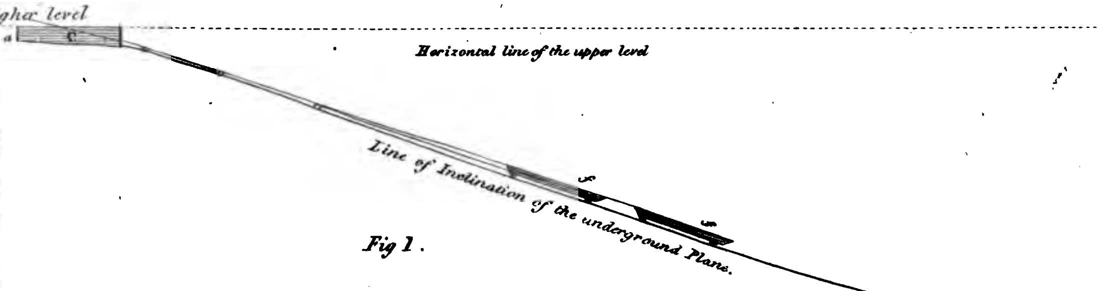
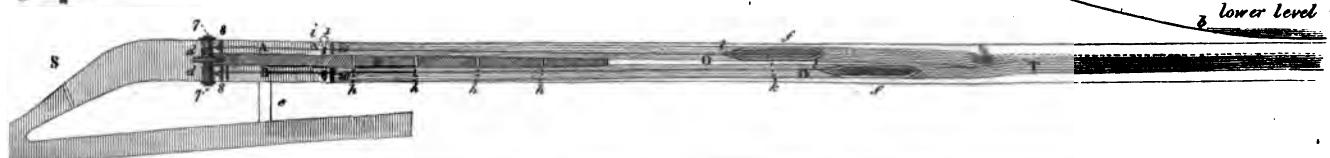



Fig 1.

The ſingularity of the place in which it is conſtructed; the original boldneſs of the deſign; the ingenuity and mechaniſm diſplayed in planning and executing it; the diſpatch with which it has been finiſhed; the ſimplicity, beauty, and harmony of its parts, tending to one united whole; and, above all, the perfection to which it is proved to have been brought, now that it is practically in uſe; render it equally aſtoniſhing with any other of the ſtupendous works which have been ſo ably planned, and ſo ſucceſsfully executed, by the firſt projector and patriotic father of Inland Navigation.

References to Plate VIII.

Fig. 1, *a* to *b*, dip of the metals and waggon-road on the under-ground inclined plane. From *b*, on the lower level, to the mouth of the tunnel, is three miles.

A, the eaſt lock.

B, the weſt lock.

C, repreſents a ſection of the lock: the dotted line ſhows the horizontal depth, and the black line under it the ſlope upon which the waggon-wheels run to receive the loaded boat, or to bring the empty boat into the lock.

d d, the main-ſhaft, four feet eleven inches diameter, upon which the ropes work to wind the boats up and down; and here alſo the break-wheel is faſtened on, together with a ſpur-wheel, and a nut-wheel. See Fig. 2, No. 1.

e, a paſſage between the higher level and the locks.

f f, a loaded boat going down, and an empty boat going up the under-ground inclined plane.

G, a brick wall, from the ſole to the top of the inclined plane, in order to give additional ſupport to the roof.

b, *b*, *b*, *b*, openings through the brick wall G, into which a perſon may ſtep out of the way of the boats at the time they are paſſing up and down.

i, a bell, which is rung by the rope dotted to *b*, upon the lower level, at the bottom of the under-ground inclined plane, to give notice when the empty boat is upon the waggon, or cradle, and when the men below are ready, that the loaded boat may be let down by the men above.

k, *k*, holdfaſt-ropes faſtened to the main-ropes, and hooked on to a ring at the ſouth end of each boat, as it goes up or down, in order to ſtay the boats upon the waggon or cradle, that they may not ſwag, or ſlip off. Theſe holdfaſt-ropes are ſpliced on to the end of the main-ropes, and run above and between the two bridle-ropes when they are faſtened to the iron uprights, which are upon each ſide of the waggons, or cradles; and they run over the north end of the boat, to be hooked on to the ſouth end.

l, *l*, the bridle-ropes faſtened to the main-ropes at O, and ſecured to two iron uprights upon each ſide of the waggon, or cradle.

O, O, the places where the main-ropes, the bridle-ropes, and the holdfaſt-ropes, are faſtened all together.

No. 1, an open ſpace driven into the ſide of the lock A, to which a pit is ſunk from the higher level, in order to convey the water out of the locks down to the lower level, and alſo to force a current of freſh air into the lower level collieries.

No.

No. 2, a paddle to let the water out of the lock A into the pit No. 1.

No. 3, a paddle to let the water out of the lock B, through a culvert, reprefented by dotted lines, under the lock A, into the pit No. 1.

No. 7, 7, paddles in the lock-gates, to let the water out of the higher level into the locks.

No. 8, 8, the two north lock-gates, one to each lock, which turn upon the heels of the gates, and fwing round when they are opened or fhut.

No. 10, 10, two ftops or cloughs, one to each lock, which ferve as lock-gates to the fouth end, and are raifed and let down by a windlafs.

S, a ftop, which is ufed occafionally when the lock-gates want repairing.

T, the place where the boats which are to pafs to or from the lower fingle waggon-way are directed, at pleafure, into either part of the double waggon-way, by a moveable iron fleeper or plate at that point, upon which fleeper or plate the wheels of the boat-carriage or cradle run.

Fig. 2, 1, main-fhaft, on which the rope laps.

2, break-wheel, on one fide of which the fpur-wheel is faftened.

3, nut-wheel, out of geer, but which flides into the fpur-wheel, when ufed to draw the empty boat into the lock occafionally, and which is fupported by two uprights from the pillar to the roof.

4, 4, winches or handles, to work the nut and fpur-wheel.

5, 5, the main-ropes faftened to the boats, and which are lapped to prevent their wearing.

6. The fpur-wheel, which is faftened on one fide of the break-wheel; and on which break-wheel is a ftrong iron-jointed timber brace,

 which,

which, according to the pressure given thereto by the man who attends it, will allow the loaded boat to descend quick or slow, or detain it in its passage.

7, 7, paddles in the lock-gates, to let the water out of the higher level into the lock.

8, a hollow cast-iron roller, to prevent the main ropes from swagging.

9. Shroud-wheel, to prevent the ropes going over the end of the main-shaft, slipping off, jerking, or breaking. This stands three inches above the main-shaft.

XXVIII. *On a new fulminating Mercury.*

By Edward Howard, *Esq. F. R. S.*

(Continued from Page 114.)

SECTION VIII.

FROM the experiments related in the fourth and fifth sections, in which the gunpowder proof and the gun were burst, it might be inferred, that the astonishing force of the mercurial powder is to be attributed to the rapidity of its combustion; and a train of several inches in length being consumed in a single flash, it is evident that its combustion must be rapid. From the experiments of the sixth and seventh sections, it is sufficiently plain that this force is restrained to a narrow limit, both because the block of wood charged with the mercurial powder was more shattered than

than that charged with the gunpowder, whilst the sand surrounding it was least disturbed, and likewise because the glass globe withstood the explosion of 10 grains of the powder fixed in its centre; a charge I have twice found sufficient to destroy old pistol barrels, which were not injured by being fired when full of the best gunpowder. It also appears, from the last experiment, that 10 grains of the powder produced by ignition four cubical inches only of air; and it is not to be supposed that the generation, however rapid, of four cubical inches of air, will alone account for the described force; neither can it be accounted for by the formation of a little water, which, as will hereafter be shewn, happens at the same moment: the quantity formed from 10 grains must be so trifling, that I cannot ascribe much force to the expansion of its vapour. The sudden vaporition of a part of the mercury seems to me a principal cause of this immense yet limited force; because its limitation may then be explained, as it is well known that mercury easily parts with caloric, and requires a temperature of 600 degrees of Fahrenheit, to be maintained in the vaporous state. That the mercury is really converted into vapour, by ignition of the powder, may be inferred from the thin coat of divided quicksilver, which, after the explosion in the glass globe, covered its interior surface; and likewise from the quicksilver with which a tallow candle, or a piece of gold, may be evenly coated, by being held at a small distance from the inflamed powder. These facts certainly render it more than probable, although they do not demonstrate, that the mercury is volatilized; because it is not unlikely that many mercurial particles

ticles are mechanically impelled againſt the ſurface of the glaſs, the gold, and the tallow.

As to the force of dilated mercury, Mr. Baumé relates a remarkable inſtance of it, as follows.

"Un alchymiſte ſe préſenta á Mr. Geoffroy, "et l'aſſura qu'il avoit trouvé le moyen de fixer "le mercure par une opération fort ſimple. Il "fit conſtruire ſix boîtes rondes en fer fort épais, "qui entroient les unes dans les autres; la der-"niere étoit aſſujettie par deux cercles de fer qui "ſe croiſoient en angles droits. On avoit mis "quelques livres de mercure dans la capacité de "la première: on mit cet appareil dans un four-"neau aſſez rempli de charbon pour faire rougir "á blanc les boîtes de fer; mais, lorſque la cha-"leur eut pénétré ſuffiſamment le mercure, les "boîtes creverent, avec une telle exploſion qu'il "ſe fit un bruit épouvantable: des morceaux de "boîtes furent lancés avec tant de rapidité qu'il "y en eut qui paſſerent au travers de deux plan-"chers; d'autres firent ſur la muraille des ef-"fects ſemblables à ceux des éclats de bombes *."

Had the alchemiſt propoſed to fix water by the ſame apparatus, the neſt of boxes muſt, I ſuppoſe, have likewiſe been ruptured; yet it does not follow that the exploſion would have been ſo tremendous: indeed, it is probable that it would not, for if (as Mr. Kirwan remarked to me) ſubſtances which have the greateſt ſpecific gravity have likewiſe the greateſt attraction of coheſion, the ſuppoſition that the vapour of mercury exceeds in expanſive force the vapour of water, would agree with a poſition of Sir Iſaac Newton,

* Chymie Expérimentale et Raſonnée, Tom. II. p. 393. Paris, 8vo. 1773.

that

that thofe particles recede from one another with the greateft force, and are moft difficultly brought together, which upon contact cohere moft ftrongly *.

SECTION IX.

Before I attempt to inveftigate the conftituent principles of this powder, it will be proper to defcribe the procefs and manipulations which, from frequent trials, feem to be beft calculated to produce it. 100 grains, or a greater proportional quantity, of quickfilver (not exceeding 500 grains †) are to be diffolved, with heat, in a meafured ounce and a half of nitric acid ‡. This folution being poured cold upon two meafured ounces of alcohol §, previoufly introduced into any convenient glafs veffel, a moderate heat is to be applied until an effervefcence is excited. A white fume then begins to undulate on the furface of the liquor; and the powder will be gradually precipitated, upon the ceffation of action and re-action. The precipitate is to be immediately collected on a filter, well wafhed with diftilled water, and carefully dried in a heat not much exceeding that of a water-bath. The immediate edulcoration of the powder is material, becaufe it is liable to the re-action of nitric acid; and, whilft any of that acid adheres to it, it is very fubject to the influence of light. Let it alfo be cautioufly remembered, that the mercurial folution is to be poured upon the alcohol.

* Newton's Optics, p. 372, 4to. Ed. Lond. 1730.

† The reafon of this limitation is not on account of any danger attending the procefs, but becaufe the quantities of nitric acid and alcohol, required for more than 500 grains, would excite a degree of heat detrimental to the preparation.

‡ Of the fpecific gravity of about 1,3.

§ Of the fpecific gravity of about ,849.

I have

I have recommended quickſilver to be uſed in preference to an oxyd, becauſe it ſeems to anſwer equally, and is leſs expenſive; otherwiſe, not only the pure red oxyd, but the red nitrous oxyd, and turpeth, may be ſubſtituted; neither does it ſeem eſſential to attend to the preciſe ſpecific gravity of the acid, or the alcohol. The rectified ſpirit of wine, and the nitrous acid of commerce, never failed, with me, to produce a fulminating mercury. It is indeed true, that the powder prepared without attention is produced in different quantities, varies in colour, and probably in ſtrength. From analogy, I am diſpoſed to think the whiteſt is the ſtrongeſt; for it is well known, that black precipitates of mercury approach the neareſt to the metallic ſtate. The variation in quantity is remarkable; the ſmalleſt quantity I ever obtained from 100 grains of quickſilver being 120 grains, and the largeſt 132 grains. Much depends on very minute circumſtances. The greateſt product ſeems to be obtained when a veſſel is uſed which condenſes and cauſes moſt ether to return into the mother liquor; beſides which, care is to be had in applying the requiſite heat, that a ſpeedy, and not a violent action be effected. 100 grains of an oxyd are not ſo productive as 100 grains of quickſilver.

As to the colour, it ſeems to incline to black when the action of the acid on the alcohol is moſt violent, and *vice verſa*.

SECTION X.

I need not obſerve, that the gaſes which were generated during the combuſtion of the powder in the glaſs globe, were neceſſarily mixed with atmo-

atmoſpheric air; the facility with which the electric fluid paſſes through a vacuum, made ſuch a mixture unavoidable.

The cubical inch of gas received over water was not readily abſorbed by it; and, as it ſoon extinguiſhed a taper without becoming red, or being itſelf inflamed, barytes water was let up to the three cubical inches received over mercury, when a carbonate of barytes was immediately precipitated.

The reſidue of ſeveral exploſions, after the carbonic acid had been ſeparated, was found, by the teſt of nitrous gas, to contain nitrogen or azotic gas; which does not proceed from any decompoſition of atmoſpheric air, becauſe the powder may be made to explode under the exhauſted receiver of an air-pump. It is therefore manifeſt, that the gaſes, generated during the combuſtion of the fulminating mercury, conſiſts of carbonic acid and nitrogen gaſes.

SECTION XI.

The principal re-agents which decompoſe the mercurial powder are the nitric, the ſulphuric, and the muriatic acids. The nitric changes the whole into nitrous gas, carbonic acid gas, acetous acid, and nitrate of mercury. I reſolved it into theſe different principles, by diſtilling it pneumatically with nitric acid: this acid, upon the application of heat, ſoon diſſolved the powder, and extricated a quantity of gas, which was found, by well-known teſts, to be nitrous gas mixed with carbonic acid gas. The diſtillation was carried on until gas no longer came over. The liquor of the retort was then mixed with the liquor collected in the receiver, and the whole ſaturated

 with

with potash; which precipitated the mercury in a yellowish brown powder, nearly as it would have done from a solution of nitrate of mercury. This precipitate was separated by a filter, and the filtrated liquor evaporated to a dry salt, which was washed with alcohol. A portion of the salt being refused by this menstruum, it was separated by filtration, and recognized, by all its properties, to be nitrate of potash. The alcoholic liquor was likewise evaporated to a dry salt, which, upon the effusion of a little concentrate sulphuric acid, emitted acetous acid, contaminated with a feeble smell of nitrous acid, owing to the solubility of a small portion of the nitre in the alcohol.

SECTION XII.

The sulphuric acid acts upon the powder in a remarkable manner, as already has been noticed. A very concentrate acid produces an explosion nearly at the instant of contact, on account, I presume, of the sudden and copious disengagement of caloric from a portion of the powder which is decomposed by the acid. An acid somewhat less concentrate likewise extricates a considerable quantity of caloric, with a good deal of gas; but, as it effects a complete decomposition, it causes no explosion. An acid, diluted with an equal quantity of water, by the aid of a little heat, separates the gas so much less rapidly, that it may with safety be collected in a pneumatic apparatus. But, whatever be the density of the acid, (provided no explosion be produced,) there remains in sulphuric liquor, after the separation of the gas, a white inflammable and uncrystallized powder mixed with some minute globules of quicksilver.

To

To eſtimate the quantity, and obſerve the nature, of this uninflammable ſubſtance, I treated 100 grains of the fulminating mercury with ſulphuric acid a little diluted. The gas being ſeparated, I decanted off the liquor as it became clear, and freed the inſoluble powder from acid by edulcoration with diſtilled water; after which, I dried it, and found it weighed only 84 grains; conſequently had loſt 16 grains of its original weight. Suſpecting, from the operation of the nitric acid in the former experiment, that theſe 84 grains (with the exception of the quickſilver globules) were oxalate of mercury, I digeſted them in nitrate of lime, and found my ſuſpicion juſt. The mercury of the oxalate united to the nitric acid, and the oxalic acid to the lime. A new inſoluble compound was formed; it weighed, when waſhed and dry, 48,5 grains. Carbonate of potaſh ſeparated the lime, and formed oxalate of potaſh, capable of precipitating lime-water and muriate of lime; although it had been depurated from exceſs of alkali, and from carbonic acid, by a previous addition of acetous acid. That the mercury of the oxalate in the 84 grains had united to the nitric acid of the nitrate of lime was proved by dropping muriatic acid into liquor from which the ſubſtance demonſtrated to be oxalate of lime had been ſeparated; for a copious precipitation of calomel inſtantly enſued.

The ſulphuric liquor, decanted from the oxalate of mercury, was now added to that with which it was edulcorated, and the whole ſaturated with carbonate of potaſh. As efferveſcence ceaſed, a cloudineſs and precipitation followed; and the precipitate, being collected, waſhed, and dried, weighed 3,4 grains: it appeared to be a carbonate

 of

of mercury. Upon evaporating a portion of the saturated sulphuric liquor, I found nothing but sulphate of potash; nor had it any metallic taste. There then remains, without allowing for the weight of the carbonic acid united to the 3,4 grains, a deficit from the 100 grains of mercurial powder of 12,6 grains, which I ascribe to the gas separated by the action of the sulphuric acid. To ascertain the quantity, and examine the nature, of the gas so separated, I introduced into a very small tubulated retort 50 grains of the mercurial powder, and poured upon it 3 drams, by measure, of sulphuric acid, with the assistance of a gentle heat. I first received it over quicksilver; the surface of which, during the operation, partially covered itself with a little black powder *.

The gas, by different trials, amounted from 28 to 31 cubical inches; it at first appeared to be nothing but carbonic acid, as it precipitated barytes water, and extinguished a taper, without being itself inflamed, or becoming red. But, upon letting up to it liquid caustic ammoniac, there was a residue from 5 to 7 inches of a peculiar inflammable gas, which burnt with a greenish blue flame. When I made use of the water-tub, I obtained, from the same materials, from 25 to 27 inches only of gas, although the average quantity of the peculiar inflammable gas was likewise from 5 to 7 inches; therefore, the difference of the aggregate product, over the two fluids, must have arisen from the absorption, by the water, of a part of the carbonic acid in its nascent state. The variation of the quantity of the inflammable gas, when powder from the same par-

* I cannot account for this appearance.

cel

cel is used, seems to depend upon the acid being a little more or less dilute.

With respect to the nature of the peculiar inflammable gas, it is plain to me, from the reasons I shall immediately adduce, that it is no other than the gas (in a pure state) into which the nitrous etherized gas can be resolved, by treatment with dilute sulphuric acid.

The Dutch chemists have shewn *, that the nitrous etherized gas can be resolved into nitrous gas, by exposure to concentrate sulphuric acid, and that, by using a dilute instead of a concentrate acid, a gas is obtained which enlarges the flame of a burning taper, so much like the gaseous oxyd of azote, that they mistook it for that substance; until they discovered that it was permanent over water, refused to detonate with hydrogen, and that the fallacious appearance was owing to a mixture of nitrous gas with inflammable gas.

The inflammable gas separated from the powder answers to the description of the gas which at first deceived the Dutch chemists; 1st, in being permanent over water; 2dly, refusing to detonate with hydrogen; and, 3dly, having the appearance of the gaseous oxyd of azote, when mixed with nitrous gas.

The gas separable by the same acid, from nitrous etherized gas, and from the mercurial powder, have therefore the same properties. Every chemist would thence conclude, that the nitrous etherized gas is a constituent part of the powder, had the inflammable and nitrous gas, instead of

* Journal de Physique, p. 250, October, 1794.

the

the inflammable and carbonic acid gas, been the mixed product extricated from it by dilute sulphuric acid.

It however appears to me, that nitrous gas was really produced by the action of the dilute sulphuric acid; and that, when produced, it united to an excess of oxygen present in the oxalate of mercury.

To explain how this change might happen, I must premise, that my experiments have shewn me that oxalate of mercury can exist in two, if not in three states.

1st. By the discovery of Mr. Ameilon, already quoted, the precipitate obtained by oxalic acid, from nitrate of mercury, fuses with a hissing noise. This precipitate is an oxalate of mercury, seemingly with excess of oxygen. Mercury dissolved in sulphuric acid and precipitated by oxalic acid, and also the pure red oxyd of mercury digested with oxalic acid, give oxalates in the same state.

2dly. Acetate of mercury, precipitated by oxalic acid, although a true oxalate is formed, has no kind of inflammability. I consider it as an oxalate with less oxygen than those above mentioned.

3dly. A solution of nitrate of mercury, boiled with dulcified spirit of nitre, gives an oxalate more inflammable than any other; perhaps it contains most oxygen.

The oxalate of mercury remaining from the powder in the sulphuric liquor is not only always in the same state as that precipitated from acetate of mercury, entirely devoid of inflammability, but contains globules of quicksilver, consequently it

it muſt have parted with even more than its exceſs of oxygen; and, if nitrous gas was preſent, it would of courſe ſeize at leaſt a portion of that oxygen. It is true, that globules of quickſilver may ſeem incompatible with nitrous acid; but the quantity of the one may not correſpond with that of the other, or the dilution of the acid may deſtroy its action.

As to the preſence of the carbonic acid, it muſt have ariſen either from a complete * decompoſition of a part of the oxalate; or, admitting the nitrous etherized gas to be a conſtituent principle of the powder, from a portion of the oxygen, not taken up by the nitrous gas, being united with the carbon of the etherized gas.

SECTION XIII.

The muriatic acid, digeſted with the mercurial powder, diſſolves a portion of it, without extricating any notable quantity of gas. The diſſolution evaporated to a dry ſalt taſtes like the corroſive ſublimate; and the portion, which the acid does not take up, is left in a ſtate of an uninflammable oxalate.

* Inflammable oxalate of mercury, made to fuſe in a retort connected with the quickſilver tub, gives out carbonic acid gas.

TO BE CONTINUED IN OUR NEXT.

XXIX.

XXIX. *Obſervations on Clarification.* *By Citizen* PARMENTIER.

(Concluded from Page 138.)

THE filters of glaſs may very well be formed in a funnel. The great art that is required in order that they may produce this effect, is firſt to fix ſome fragments of glaſs in the tube, afterwards to add other ſmaller ones, and thus to continue, always diminiſhing the ſize of the fragments, till we have formed a thickneſs of three or four finger's breadths, the upper layer of which ought to be glaſs reduced to fine powder.

This kind of filter lets the liquid paſs through with ſufficient facility, that in leſs than an hour it is poſſible to filtrate ſeveral killogrammes of acid, in a funnel of glaſs of a moderate ſize.

Sand is alſo very commonly uſed for clarifying the water employed for domeſtic purpoſes. The ciſterns lined with ſand are in fact real filters, the effect of which is the more certain, the more the layers of ſand are diſpoſed in ſuch a manner, that the water which covers them is obliged ſucceſſively to paſs through them, and that they retain the ſubſtances which injure its tranſparency.

The art of conſtructing ciſterns lined with ſand has not yet arrived at the degree of perfection to which it might be brought, and though its object may ſeem to be of but ſmall importance, it nevertheleſs well deſerves the attention of philoſophers.

For

For the reft, experience proves that cifterns lined with fand can be ufed with advantage only during a certain time; frequently it is neceffary to renew the fand which they contain, or at leaft to wafh it, in order to deprive it of the earthy and heterogeneous fubftances which the water depofits in it, and which, when they have accumulated to a certain degree, not only prevent the filtration, or render it incomplete, but alfo communicate to the liquid a tafte, which is the more difagreeable the longer they have remained in it.

Nothing is more eafy, as is well known, than to deprive the water of rivers of the earth which it often carries along with it, and which impairs its tranfparency. All that is required, is to let it ftand for fome hours in an earthen veffel, but uncovered, for the action of the air is neceffary in order to effect this precipitation in a fpeedy and complete manner.

However, though the practice of filtering water deftined to be ufed as drink is to be traced to the moft remote antiquity, it muft be confeffed, that the cifterns eftablifhed for this purpofe do not only free them of the mud which rendered them turbid, but likewife deprive them of a fuperabundance of air with which they are fometimes impregnated, a fuperabundance which conftitutes their lightnefs, their fharpnefs, &c. in a word, that fuperiority which the water of the Seine, for example, has over that of all known rivers. The proof that this is the cafe, is that by dint of repeated filtrations one may render water infipid, heavy, and unwholefome.

Thus when one wifhes to determine the fpecific gravity of the water of the Seine, one ought to

take it from the river on a day when it is limpid, or at leaſt let it clear itſelf by ſtanding, and not chooſe the filtered water in preference; for if this operation renders water more clear, it at the ſame time produces conſiderable changes in it, by depriving it, as has been remarked, of the air which it contains in ſuperabundance.

I have known a perſon whoſe organs of taſte were rendered ſo acute by exerciſe, that he could diſtinguiſh water that had been filtered through ſand from ſuch as had not, by the different impreſſions which that made upon them. The latter appeared to him to be more ſapid and light. This undoubtedly proceeds from the abſence of the air, we have mentioned, and which may be ſtill more diſtinctly perceived under the recipient of the pharmaceutical apparatus. Some perſons, intereſted in ſupporting the opinion contrary to that which has been advanced above, have aſſerted that if the water were continually obliged to paſs through ten feet of ſand and gravel from below upwards, it would be in a condition to produce, with the weight of the heterogeneous ſubſtances, an effect capable of contributing to purify it completely, that is to ſay, to deprive it of its ſalts: the prepoſſeſſion was ſo great that the following reaſoning was adduced in favour of this notion.

"If theſe filters are ſufficient for depriving the water of its air, why ſhould not this operation of filtration be equally proper for depriving it of the ſalts which it contains?" but attention has not been paid to the circumſtances that theſe ſalts, held in ſolution in the water, being of greater ſpecific weight, filter themſelves together with it through the ſmalleſt tubes, whilſt the air, be-

ing specifically lighter than the water, and existing in it in a state different from that of the salts, separates itself easily; finally, it has also been attempted to apply filtration to the water of the sea, with a view to render it palatable; the process for this purpose has been announced to government as a new and ingenious invention; it consisted in a filtration which was effected from below upwards by the application of force.

But the union of the saline substances with the water is not a mere mechanical state of division; they are not merely interposed between its particles, as some philosophers have maintained, but they are perfectly dissolved in the water, and possess a degree of fluidity equal to its own. These salts consequently become capable of passing through filters with the most minute pores. It is therefore only by reducing the water to the state of vapours that we can separate the saline substances which it holds in solution, and no other expedient than distillation will ever produce a satisfactory effect. But let us resume the subject of the general effects of filtration.

Besides the filters of which we have already treated, the stones known by the appellation of filtering-stones are also employed for clarifying water. Of these there are several kinds; they are very porous, as they consist for the greater part of free-stone. They are hollowed out and filled with water. This fluid gradually insinuates itself amongst their pores, and appears on the outside in the form of clear drops, which fall into a receptacle upon which the stones are placed.

These stones ought previously to be washed several times with water; it is even remarked, that

the water which is filtered through them during the firſt days has a diſagreeable taſte, which depends upon the foreign ſubſtances this fluid has diſſolved in paſſing through the ſtone; ſo that it is not till the water which paſſes through has no longer any peculiar taſte that it is fit to be uſed for drink.

Upon the whole, the filtering-ſtone, as it has been extolled, is a bad means for procuring good water. Beſides, the filtration proceeds very ſlowly, and frequently even ceaſes to take place, unleſs we uſe the precaution of rubbing both the inſide and outſide of the ſtone, from time to time, with a hard bruſh, in order to detach the mud which the water depoſits upon it. It is undoubtedly to theſe inconveniences that we ought to attribute the diſrepute into which this kind of filtration ſtands at preſent.

It now only remains for us to ſpeak of the proceſſes employed, in order to give different fluids that perfect limpidity, which they can never acquire by ſpontaneous clarification and by means of filters, of whatever kind they may be.

If it be true, that the opacity obſervable in certain fluids is entirely owing to the interpoſition of molecules which are not diſſolved, but merely ſuſpended in them by the aid of a ſtate of extreme diviſion, it is certain alſo, that under other circumſtances the deficiency of tranſparency depends entirely upon the imperfect ſolubility of one or more ſubſtances which theſe fluids contain; ſo that in order to give them the deſired limpidity, it is abſolutely neceſſary to have recourſe to means which augment the ſolubility of the ſubſtances in queſtion, or at leaſt effect their total ſeparation.

Albuminous

Albuminous and gelatinous matter, the acids, certain salts, lime, cream, blood, alcohol, may in many cases contribute to effect the clarification of certain fluids, for which the ordinary filters would be inadequate. However, these agents are not to be used indiscriminately, and the preference which is given to the one above the other always requires to be determined according to the knowledge which we have of the composition of the liquid we wish to clarify. Accident has discovered, for example, that two handfulls of marl, reduced to a coarse powder, and thrown into the pressing tub, clarify cider.

The effect of the albuminous and gelatinous matters is principally remarkable in the vinous liquids. It is on this account that they are employed when it is required to fine wines, that is to say, when we wish to give them that high degree of limpidity which they can rarely acquire, and preserve by mere repose. In this case, nothing more is required, than to dissolve either of these two substances in a small quantity of water, and to mix this solution cold with the wine; a short time after, a kind of net-work is observed throughout the whole mixture, which soon contracting together collects all the foreign substances from the wine, and carries them with it to the bottom of the vat.

In other instances, one is obliged to heat the liquids with which we mix the albuminous matter; and it is only at the moment of ebullition that the clarification takes place. The most of the syrups are clarified by this process, and no other has yet been discovered that produces a better effect.

It

It is alſo obſerved, that albuminous matter alone is not always ſufficient to clarify liquids, even though we raiſe them to a degree of temperature ſufficient to make them boil, but that it is neceſſary to aſſiſt its operation by means of an acid, or a ſalt with a redundance of acid. In proof of this, we may adduce what takes place in the clarification of whey.

In fact, it is demonſtrated that it is only when we add to this fluid, at the moment when it begins to boil, ſome acidulous tartarite of potaſh (*cream of tartar)*, or vinegar, that the albuminous matter with which it had previouſly been mixed, coagulates and carries with it the caſeous matter, which impaired the tranſparency of the ſerum.

For the reſt, it is eaſily conceived that the quantity of acid which it will be proper to add in this caſe, muſt always bear a relation to the ſtate of the fluid, and that it would be ridiculous to pretend that the proportion can be fixed in an invariable manner.

New cream is employed with advantage for clarifying ſpirituous liquors: one or two ſpoonfuls to the pint are ſufficient to produce this effect in the ſpace of a few hours in the cold. But as in this clarification, ſome caſeous particles always remain ſuſpended in the fluid, by reaſon of their great tenuity, it is neceſſary to ſeparate them at laſt by filtration through a bag or through paper.

Finally, there are ſome fluids, which, in order to become clear, require to be ſubjected to a degree of heat nearly approaching that of boiling water. Theſe are principally ſuch as are rendered opaque merely by ſubſtances, the ſolubility of which cannot become complete, unleſs it be facilitated

cilitated by raising the temperature of their solvent above its natural state. Many saline solutions stand in this predicament, and whoever occupies himself ever so little with chemistry, will frequently meet with such.

Most of the fresh-expressed juices of vegetables may also be partially clarified by the operation of heat. Thus it is customary amongst apothecaries to have recourse to this means with those juices which, on account of their thickness and viscosity, are not susceptible of being filtered.

Frequently a slight degree of heat, applied to the expressed and filtered juices of certain vegetables, is sufficient suddenly to destroy their transparency; in this case a flaky, whitish substance floats in the liquid, and collects at the bottom of the vessel. This is the substance which Rouelle, the younger, considered as the vegeto-animal matter of corn, and which I demonstrated, as far back as the year 1772, to be nothing more than a substance analagous to the white of egg; which proves that at that period we were upon the way to inscribe albumen amongst the products of the vegetable kingdom.

An important observation, upon which I ought to insist, is that in general it appears absolutely necessary to separate the *magma*, which forms in liquors that are clarified with albuminous matter, especially when, in order to concentrate those liquids, it is necessary to evaporate them by the aid of ebullition. Without this precaution, this *magma* would dissolve, and the liquors would become more turbid than they were previous to the clarification. It proceeds from a similar cause, that broth, from which the scum has not been taken

taken off, always retains a disagreeable appearance, and will not keep.

Though the employment of albuminous matter for clarifying the juices of certain vegetables be of utility, it is, however, not without its inconveniences. Amongst others, one that has been remarked is, that it changes the nature of these fluids in such a manner, as partly to destroy their medicinal properties. It is known what happens to certain pharmaceutical preparations, such as decoctions of medicines, when, in order to clarify them, recourse has been had to white of egg and heat; for then they are almost without effect, unless we take care to double the proportions of the ingredients that ought to enter into their composition. *Lewis* has remarked that this operation deprived the syrup of diacodium of all its powers.

These are the observations which I thought would be useful to collect on the subject of clarification. My intention in communicating them was to shew, that such an operation, though simple in appearance, must not be performed in an indifferent manner, and that, amongst the various processes that are in common use, some do not present results equally satisfactory with those of others. The choice ought therefore always to be determined according to the nature of the substances upon which we have to operate. I confine myself to the relation of the facts; to others I leave it to give the explanations of them that may be desired.

XXX.

XXX. *Report to the Society of Mines, concerning a new Procefs for the Converfion of Wood into Charcoal: invented by Citizen* BRUNE, *Proprietor of the Forges of Sorel, near Anet.*

By the Citizens BLAVIER *and* BROCHIN.

IN a report addreffed by one of us to the fociety of mines, laft Frimair, concerning a procefs of citizen Fremin, in which wood is converted into charcoal, by diftillation, in clofe veffels, we announced fome very interefting refults with refpect to the augmentation of the product; at the fame time expreffing our regret, that the execution of the procefs was fo difficult and expenfive, and that the charcoal had not thofe properties which can alone render it ufeful for all the purpofes for which it is employed.

The procefs of citizen Brune fupplies completely, and beyond all expectation, every thing which was wanting in that of citizen Fremin, as, befides doubling the product in charcoal, the apparatus is fimple, and may be eafily conftructed, at a very fmall expenfe.

The experiments which have lately been made at Paris, at which we affifted by order of the fociety of mines, leave no doubt as to the great fuperiority of this procefs, above all others which have hitherto been known. We think it proper to premife an account of thefe experiments, by a defcription of the apparatus, and of the means employed by the inventor.

Description of the Apparatus.

A hole is dug to the depth of from four to five decimeters, (from 15 to 18 inches), the diameter must be equal to the bottom of the furnace; this hole is covered with plates of iron rivetted one upon another, and supported on a frame composed of bars of iron; the parts which are not sufficiently joined must be carefully luted.

The furnace is constructed on these iron plates, in the same manner as in the process most commonly employed; that is, a triangular prism, composed of billets laid lengthways on each other, forms the nucleus, around which the wood is placed, so as to give the form of a truncated cone; but this hollow prism, which, in the common furnaces, serves the purpose of a chimney, is here applied to a different purpose, for its interior is furnished with billets, disposed vertically along the whole height of the apparatus.

The furnace thus constructed, with a basis which is or ought to be of a surface equal to that of the iron plates, is covered over with leaves, and a thin stratum of twigs mixed with earth.

Besides the aperture that gives access to the hole which serves for the ash-pit, three air-holes are formed, which communicate from the interior of the hole to the outside of the furnace; one of these air-holes is directly opposite to the principal aperture, and the two others are at an equal distance from the first, and form this principal aperture.

EXPERI-

Experiments on the Process of Citizen Brune.

Experiment A. The furnace which was conſtructed under our inſpection was compoſed of 7884 cubic decimeters (230 cubic feet) of freſh oak-wood, ſtripped of its bark; the billets were 54 centimeters (nearly 20 inches) in length. To aſcertain the weight of the wood employed, we had a pile of it weighed, containing 567 cubic decimeters, the weight of which was found equal to 269 kilograms, (275 pounds), from which it may be preſumed, that the whole weight of the wood employed in the furnace was equal to 3743 kilograms (3826 pounds).

The furnace was diſpoſed as we have deſcribed it above, with this exception, that the plates of iron joined together formed a ſquare of three meters 25 centimeters, (10 feet), and that the baſis of the furnace was 48 decimeters in diameter, (nearly 15 feet), ſo that a part of the baſis extended beyond the iron plates, a defect which ought to be avoided, and which aroſe in tbis inſtance from the employment of the firſt iron plates which were at hand.

It was ſet on fire the 20th Ventoſe at ten in the morning; two ſmall faggots formed of ſlight branches had been previouſly put in the centre of the hole; after they had been ſet on fire, four ſimilar faggots were ſucceſſively added; at 15 minutes after 10, the humidity of the wood turning into gaz, exhaled from all parts of the furnace; at 45 minutes after 10, the combuſtion began, and was rapidly communicated to all points of the baſis of the apparatus.

 At

At 11, all the apertures of the hole were closed; and a passage for the air into the furnace was formed, by making holes gradually from bottom to the top, while care was taken to accelerate the combustion in those parts where it appeared to be retarded, and to cover those with earth from which the vapours issuing more abundantly showed the ignition to be too active: these are the only precautions which the management of the furnace, and the direction of the combustion, require.

The furnace was extinguished on the 22d, at two in the morning; so that the duration of the combustion was 40 hours.

On the 24th, the charcoal being uncovered, we had it measured, it filled 22 measures and a quarter, the measure being a cubic chest of the capacity of 274 decimeters (8 cubic feet), which gives 6101 cubic decimeters (178 cubic feet) of charcoal as the product of the combustion.

Two hundred and seventy-four cubic decimeters (eight cubic feet) of charcoal, we found to weigh 52 kilograms 864 grams; (108 pounds), so that the weight of the 6101 cubic decimeters of this combustible may be estimated as equal to 1176 kilograms, and the cubic meter should weigh 192 kilograms 755 grams (13 pounds 8 ounces the cubic foot.)

Experiment B. A similar experiment was brought to a conclusion on the day we were assembled: we think it our duty to make it public, and explain the results, as these two experiments may be adduced in confirmation of each other. The experiment in question was made in the presence of citizen Molard and several masters of forges,

forges, on the ſame ſpot as the former, of which we have given an account, and with the ſame ſort of wood diſpoſed in the ſame manner.

The furnace was compoſed of 7412 cubic decimeters of wood, it was ſet on fire the 15th Ventoſe at half after eight in the morning; the furnace began to be ignited at half paſt ten, the combuſtion ceaſed the 17th at two in the morning, and its duration was therefore 41 hours and 30 minutes.

The charcoal which reſulted from this operation was meaſured in our preſence; the meaſure was cubic, and contained 294 cubic decimeters, 19 meaſures were filled, which gives us the total of charcoal, 8592 cubic decimeters.

Having, moreover, cauſed a meaſure of charcoal to be weighed, we found that the weight of the cubic meter, was 208 kilograms 160 grams, (14 pounds 10 ounces the cubic foot.)

That no doubt might remain about the reſults of the foregoing experiments, and that they might be brought to an exact compariſon with the moſt ordinary mode of converting wood into charcoal, we thought it eſſential to repeat the experiment, by performing the two proceſſes at the ſame time with equal quantities of wood of the ſame kind.

The identity of the products obtained in the experiment A and B, the ſtate of the atmoſphere, which varied very little during the whole time that the three experiments laſted, and the precautions which were taken to obtain exact reſults, are a further proof of the exactneſs of the relations which ſubſiſt between the products furniſhed by the two proceſſes.

Experiment

Experiment C. *on the Conversion of Wood into Charcoal according to the Common Process.*

The furnace was composed of 7368 cubic decimeters of green oak-wood, stripped of its bark, and like that which was used for the preceding experiments.

The wood arranged according to the ancient method, and covered with leaves and earth, as is commonly practised in small furnaces, was set on fire the 25th Ventose at seven in the morning; it ceased on the 27th at four in the morning, which gives a duration of 45 hours.

On the 28th at eight in the morning, the charcoal was uncovered; after having separated the uncharred pieces, we measured the charcoal which remained, which amounted to two meters 742 cubic decimeters (80 cubic feet); the quantity of uncharred pieces, amounting to 274 cubic decimeters, formed an eleventh of the total product.

The weight of 274 cubic decimeters (eight cubic feet), being found to consist of 53 kilograms 361 grams (109 pounds), we deducted the weight of the cubic meter, amounting to 194 kilograms 594 grams; that of the cubic foot amounts to 13 pounds 10 ounces.

The comparative table is as follows:

Comparative

Comparative Table of the results produced in the three Experiments. *

For eight cubic metres of wood, weighing 3798 Kilogrammes 198 grammes.

	Product in Charcoal. Volume. Cubic decimetres.	Product in Charcoal. Weight. Kilograms.	Duration of the Combustion.	Proportion between the product in Charcoal and the Wood employed. Between the Volumes.	Proportion between the product in Charcoal and the Wood employed. Between the Weights.	Weight of the cubic metre of Charcoal. Kilograms.
Experiment A.	6214	1196	40 hours	77 : 100	15 : 100	193
Experiment B.	6119	1272	41 h. 30 m.	76 : 100	16 : 100	208
Experiment C.	2982	578	45 hours	37 : 100	7 : 100	195

* We have referred all the results to one, and the same quantity of wood, in order that the proportions may be more easily understood.

OBSERVA-

Observations.

We fhall add only a few obfervations on this table.

It appears that in the experiment A, the weight of charcoal is lefs than in the experiment B; this difference arifes from the charcoal having been more burnt in the former than the latter, which we had already perceived before we compared the weights: independently of this circumftance, owing to the fatigue of the workman who had watched feveral nights, it is certain that the product would have been greater, and the combuftion of fhorter duration; becaufe the fpot on which we operated had been warmed before the firft operation.

Independently of the great fuperiority of the product of charcoal, according to the procefs of citizen Brune, a very great advantage refults from the employment of it, which is, that it leaves no uncharred pieces; the bafis of the furnace entering into combuftion almoft inftantaneoufly, by means of the power of conducting caloric in the iron plates on which the apparatus is conftructed, the combuftion continues gradually and uniformly to the fuperior parts of the furnace; whereas, in the ordinary procefs, the combuftion beginning in the centre and communicating flowly, the wood which is in that part is burnt before that which is near the furface of the furnace, and particularly that on the bafis, have paffed into combuftion; and for this reafon a great part of the wood which touches the ground, principally near the borders, is always incompletely reduced to charcoal.

In the experiments according to the procefs of citizen Brune, we have alfo found fome uncharred pieces,

pieces, but in ſmall quantity, which aroſe, as we obſerved above, from the baſis of the furnace being extended beyond the iron plates, a particular circumſtance from which no induction ſhould be known, as it is a fault which may eaſily be avoided.

For the operations of which, we have given an account that much leſs conſiderable quantities of wood were employed than thoſe with which furnaces are uſually conſtructed: now, it is known that, in the ordinary proceſs for converting wood into charcoal, the proportion between the product in charcoal and the wood employed diminiſhes in the ratio of the augmentation of the volume of the furnaces, or rather of the ſurface of the baſe, ſo that in carrying the proceſs into execution, one has greater profit, with reſpect to the products, by conſtructing ſmall furnaces.

By means of the proceſs of citizen Brune, this progreſſive diminution of the product in proportion to the augmentation of the volume will be done away, or at leaſt it will be rendered leſs perceptible, as it will be eaſy in all caſes almoſt inſtantaneouſly to heat the frame of iron plates upon which the furnace reſts, whatever ſurface it may preſent.

Trials of the Charcoal.

We have made ſeveral trials of the charcoal produced in the comparative experiments; but as we were not provided with the means of making theſe trials upon a large ſcale, and as the reſults which we obtained preſented ſome variations, in ſpite of the precautions which we had taken, variations which are to be attributed to thoſe of the atmoſphere, we ſhall abſtain from making them

 public,

public, apprehensive lest they might give occasion to conclusions that might be contradicted by experience. We ought, however, to remark, that the very slight differences which we have observed are in favour of the charcoal produced by the method of citizen Brune: moreover, it will be easy for the masters of forges, whom this discovery more particularly interests, to make sufficient comparative trials.

Note, We find by the register, that the ordinary cord of wood of eight feet in length, two and a half in breadth, and four in height, containing eighty cubic feet of wood, has produced, and, when the wood is good, always will produce, seven sacks and a half of charcoal, each sack weighing more than the charcoal produced by the old process, and of the best quality.

XXXI. *Description of newly-invented moveable Forcing-frames for Plants, &c. By* Bénard, *Member of the Agricultural Society of Seine & Oise.*

WITH A PLATE.

Read at a public Sitting of that Society.

It is uncertain whether the ancients were acquainted with any artificial means of accelerating vegetation; countries inhabited by the Greeks and Romans not compelling them to seek the assistance of art to supply any deficiency in the liberality of nature.

With regard to our own ancestors, it appears that the objects of husbandry being then equally rude

tude with the hands employed in its labours, and governed by many ridiculous practices converted by superstition into irrefragable laws, agriculture was wholly destitute of that estimation which is so requisite to animate every species of human industry.

On this subject mention has been made of the kitchen-gardens established by order of Francis I, at Anet, near the forest of Yvri, under the inspection of a skilful gardener named Martin; but it appears that it was for Henry IV. at St. Germain-en-Laye, that arcades open to the south were first erected for accelerating the growth of peas.

La Quintinie, who formed the superb kitchen-garden at Versailles, scarcely made any farther advances; it is well known that fruits and flowers were at that time brought by post from Provence to Lewis XIV. for the gratification of his court.

Fagon, at the Jardin-des-plantes, at Paris, caused some glazed sashes to be constructed for foreign plants, which, for want of sufficient light, could not flourish in the green-houses built for orange-trees such as the superb *orangerie* at Versailles. To those sashes were added stoves and furnaces. But these methods were scarcely applied to forcing fruit till the reign of Louis XV.

We are assured that an Englishman named Gordon was the first who made experiments of this kind in consequence of observing that a vine-branch, which accidentally entered between two sashes of a window, put out leaves long before the rest of the stem, and that the forced grapes it produced ripened better.

Hence arose all the hot-house sashes, the frame-lights, hand-glasses, or covers, formed of small

panes of glaſs, joined together in leaden frames, and thoſe formed of large plate-glaſs. At length Richard Senior built both for himſelf at St. Germain, and afterwards for the king at Trianon, hot-houſes, in which were ſeen, for the firſt time in France, peaches, cherries, plums, ſtrawberries, apricots, and vines, bearing fruit in the depth of winter, and lilacs, roſes, honeyſuccles, ſeringas, hyacinths, narciſſuſes, and other flowers in full bloom.

In the *Ecole du Potager*, written by *Combles*, about 1750, are the details relative to the management of the glaſs covers and ſaſhes; but a great improvement ſtill remained, which has been accompliſhed in the invention of the forcing-frames, *(Pavillons de primeurs,)* to which M. Bénard has been led by various and ſucceſſive attempts now ſubmitted by him to the public. As it has fallen to my lot to give an account of theſe attempts, and of the management of them, I ought in the firſt place to ſtate the dimenſions of the frame-lights compoſed of only two parts.

The lower part *a*, (ſee Plate VIII. Figs. 3, 4, 5,) is formed by the union of two ſquare ſaſhes, the lower about 13 decimeters, (4 feet French,) the upper only 9.

The latter is raiſed above the former about 5 decimetres, (13 inches French,) and the two are joined by ſmall iron rods fit for the reception of the panes of glaſs.

The upper part *b*, conſiſts of a wooden ſaſh, bearing alſo four iron rods at the corners, and four in the middle, joined together at a ſingle point *c*, where a heavy ring is affixed; the inclination of this upper part being leſs rapid, as in the broken roofs *(toits briſés)* of the common green-

green-houses: it is only 3 decimetres by 8 for the half breadth.

During the time when the vegetation having grown up requires more height in the building, a height of wood may be placed between the two portions so as to raise the upper part one decimeter at least; another placed below would raise the whole, when needful, more than two.

From this arrangement of the glass arises a mass of light extremely valuable to vegetation. The proximity of the glass is another advantage, which is the more important as it is well known that plants kept under glass become *étiolé*, that is, grow weak by lengthening themselves to excess in order to reach and touch the glass near which the influence of the sun is always greatest. And, lastly, the inclination of the glass, and its being placed in three different plains, increases more and more the effect of the solar heat.

Shutters applied in succession, whether toward the north or toward the sun, protect the plants from the cold, or shield them from an excess of heat, and may be used throughout the whole during the winter nights.

Thus, with mere glazed frame-lights, a great number of young and delicate plants may be reared, especially the finest melons and cantaloups; or more common productions may be accelerated, as strawberries, French-beans, and the early cabbages, as well as a variety of flowers: or smaller erections may be made for these various uses; but the extent of the ground thus preserved from the chilling moisture of cold rains is an advantage not to be neglected or forgotten; and frame-lights, of 13 decimeters square, being easily removed by one man, or cultivated to the midst

midſt of them, that ſize appears moſt convenient.

All this, however, conſtitutes but half the merit of theſe hot-houſes. It is evident they may be placed over a hot-bed, accompanied with chafing diſhes, and their ſhutters covered and ſurrounded with horſe-dung when needful; though, as is well known, the heat of that ſubſtance, which is often difficult to be obtained, is ſtill more difficult to be kept up.

The heat of furnaces is liable to the ſame objections on account of their extent, even in the ſmalleſt hot-houſes. Another defect in theſe buildings is the diſtance of the plants from the glaſs. A third ariſes from the great maſs of air heated to a loſs; not to mention the no leſs important maſs of the materials, naturally cold in themſelves, of which the walls are built. Laſtly, their being ſtationary is one of the greateſt obſtacles to their being employed in horticulture. They are an expenſe only to be incurred by land-owners, and by land-owners who live in affluence, or by an extremely ſmall number of gardeners, induſtrious enough to derive from their hot-houſes a quantity of fruit, which, if it does not enrich, indemnifies them at leaſt for the expenſes attending this method, which has hitherto been the only one known.

All theſe inconveniences ſeem to be avoided by the frame-lights to which M. Bénard has adapted an apparatus for procuring heat from a kind of fuel equally convenient and œconomical, namely, two ſmall furnaces, in one of which *b* is placed a ſtrong earthen pan filled with the dregs of oil, or two, in caſe of extreme need; a ſecond furnace *g* above, with another pan placed there at the

the time when the fire is lighted; an iron pipe *f* placed at the bottom of the frame, to warm the wood and earth by means of the smoke passing through it; the circulation of which smoke is furthered by the second furnace, where the end of the pipe passing through it receives a local heat, which rarifies the air throughout the whole pipe; a wooden box *j*, to inclose these parts, which are constructed of thin materials; an iron pipe *i*, terminating, if needful, in a T, to carry off the smoke when it has become useless. This is the whole apparatus, and about a kilogram of oil *per* night, value 12 and 15 cents the whole expense. 5 or 600 francs at most laid out in constructing two of these forcing-frames, with fire-apparatus, and four without, which are necessary for placing more at large the plants reared in the former, ought, according to M. Bénard's estimate, whose experience on this subject renders his opinion decisive, to produce as much effect as a hot-house that has cost 3 or 4000 francs, and which would require a consumption of several fathoms of wood.

The œconomical gardener also finds an advantage in having it in his power to keep the parts not actually in use under cover, by which they last longer, and their expense is consequently diminished.

Lastly, by substituting a number of these forcing-frames for one hot-house, an advantage which must be considered as almost invaluble is obtained; that of varying the temperature, and accommodating it to the different plants they contain, as well as to their various periods of vegetation.

XXXII.

XXXII. *On bleaching the Pulp for manufacturing Paper. By Citizen* Loysel.

FROM THE *ANNALES DE CHIMIE.*

Every one knows the advantages attending Mr. Berthollet's method of bleaching thread and linen with oxygenated muriatic acid. Chaptal has usefully employed it in restoring the whiteness of paper used for engraving and printing; and he has lately still farther simplified one of its most important branches by his new processes in the art of managing lixivia.

The adoption of the method of Berthollet in the manufactory of paper, may carry that branch of human industry to a degree of perfection yet unknown, especially in France; for though we possess in abundance the raw materials for making paper, yet such are the methods now pursued by our manufacturers, that only a very small portion of the rags employed is adapted to making white and fine paper; all the remainder being condemned to the production of the inferior qualities.

But the bleaching of the pulp of paper, even when made from the most inferior rags, may give it the quality of that produced from rags of the finest sorts; and therefore this improvement will not only enable our manufacturers to supply all our domestic demand for white and fine paper, but may also insure us the preference in foreign markets. The result of this operation would be

the employment at home of a greater number of manufacturers, and the ſaving of the profits of this manufacture, which are preferable even to thoſe of the exportation of our raw materials in ſearch of a foreign market.

The ſucceſs of the method of bleaching the pulp of paper propoſed by Mr. Berthollet is now no longer problematical; the application of it to the paper for aſſignats has placed it beyond all doubt.

It was at the commencement of the year 2 that the committee of aſſignats and monies of the National Convention, of which committee I was a member, determined to employ this method, in order to increaſe, by uniting it with that of ſtereotypes, which they had then recently adopted, the obſtacles to the forgery of aſſignats.

We therefore conſulted, in particular Meſſrs. Berthollet, Fourcroy, and Guyton, on this plan, which their aſſent and information relative thereto ſoon enabled us to execute. We were equally aſſiſted by the information of Welter, Athenas, Alban, Carny, Marchais, and Ribeaucour, who moſt readily communicated to us their proceſſes, and permitted us to ſee them performed at their manufactories.

I ſhall not here relate all the preliminary experiments we made previous to eſtabliſhing our works on a large ſcale; I ſhall content myſelf with ſuccinctly indicating the point from which we ſet out, the agents we employed, and the means that appeared to us the moſt ſimple for arriving at the end propoſed. I ſhall then ſubjoin ſome obſervations on the means of improvement, which the advances of the ſcience ſince that period admit of applying to theſe operations.

In our first procedures we adhered rigorously to the method of Berthollet; the rags were successively submitted to the various lixivia, and to the baths of bleaching-liquor and sulphuric acid mentioned in his memoir. Berthollet had shown, and we were equally convinced by our own experience, that in the bleaching-liquor, prepared without the addition of fixed alkali, the gas being less strongly combined than in that to which is added a solution of potash or soda, it is more easily disengaged, and more readily enters into new chemical combinations. At first, therefore, we employed this simple liquor; but the workmen presently expressed so great an aversion from it on account of its smell, by which they were much incommoded even when used with the addition of lime-water, that we were obliged to abandon that method, though with regret; a sacrifice which was increased by the loss of time, and great additional expenses to which it gave birth. We determined therefore to receive the gas in a solution of potash; but, as the quantities of this alkali that can be employed have very extended limits, we endeavoured to confine ourselves as nearly as possible within those which suffice to prevent the spontaneous liberation of the gas, and thus to deprive the liquor of the smell we were desirous to obviate. This quantity was 5 kilograms of potash to 100 litres of water.

The rags thus bleached acquired a most brilliant white, though a part of this brilliancy disappeared when the rags were converted into pulp, and the pulp into paper. Of this we easily discovered the cause; namely, that the internal parts of the threads of which the rags consisted were less exposed to the action of the liquor than the

the surface. Hence we determined to abandon the plan of bleaching the rags, and apply our operations to the pulp.

But here new obstacles occurred. When the rags are converted into pulp fit to be made into paper, the cohesion of this pulp is such that it contracts and prevents the lixivia and bleaching-liquors from penetrating into all its parts; from which circumstance arise veins, and different shades of colour in the paper. This inconvenience we remedied by bleaching the materials in an intermediate state between that of rags and that of pulp ready for forming into sheets; in which we succeeded by causing them to be torn or unravelled by a preparatory cylinder, so as to destroy the texture of the rags, and separate the fibres, of which the threads consisted. For this operation 50 kilograms generally required two hours. Thus, by proceeding step by step, we advanced towards the object of our experiments.

The apparatus invented by Citizen Welter, and described by Berthollet, in the first volume of the Journal of the Arts and Manufactures *, is applicable to all the methods that can be employed for procuring the various kinds of bleaching-liquor, whether the water of the receiver contain fixed alkali in solution or not; or whether in the distillation the muriatic acid be employed on the oxyd of manganese; or, lastly, the gas be obtained by the sulphuric acid on a mixture of oxyd of manganese and of muriate of soda. It is particularly preferable to all others when the water of the receiver contains no alkali, because the absorption of the gas is in that case favoured by bringing it in contact with the water

* See our first volume, page 53.

 in

in a great number of points. But as we had determined to employ a solution of potash, we were enabled to make some modifications in this apparatus.

1. The three interior cisterns of the receiver were reduced to one. Ours was formed of a tub, containing another, turned downward, and both were covered with sheet-lead.

2. The size of the communicating tubes secured them from being choaked up during the distillation.

3. The convenience of the workmen in the management of the fire, and the advantage of having but one aperture to lute, induced us to suppress the intermediate vessel.

Description of the Apparatus used in the Preparation of oxygenated muriatic Acid for bleaching the Pulp of Assignat-Paper.

Fig. 1. Plate IX. Plan of the apparatus.

1, 1, &c. Eight furnaces, each pair of which has a common chimney, of iron plate.

2, 2, &c. Eight cast-iron pots, containing sand-baths.

3, 3, &c. Eight matrasses, balloons, or bodies of earthen-ware, well baked and compact, to contain the substances from which the gas is to be obtained. Each matrass is to be only two-thirds full at most. Glass balloons, of little thickness, may be employed with equal advantage.

4, 4, &c. Glass tubes for conducting the gas into the receiver. These may likewise be made of lead.

5. The

5. The receiver, compofed, 1ft, of an external tub, covered with fheet-lead well foldered, and furnifhed with a cock (6) near the bottom, for drawing off the liquor when prepared; 2ndly, of another tub (7), alfo covered with fheet-lead both without and within. This fecond tub is turned upfide-down in the former, to contain the gas in proportion as it is difengaged, and to keep in contact with the water of the receiver the part which has not had time to be taken up by it while paffing through.

8. A hole in the upper part of this fecond tub. This hole being open affords a paffage to the atmofpheric air when water is poured into the receiver. It is then clofed with a leaden ftopper or a cork, covered with paper fteeped in ftarch, and fecured with linen or bladder tied down previous to the operation.

Fig. 2, A vertical fection of the apparatus.

Fig. 3, Elevation of the fame.

The placing the furnaces round the receiver and the round form of the tubs were rendered neceffary by the localities of the laboratory where we were obliged to perform our operations. In another fituation we might have employed fquare veffels, and placed all the furnaces in a ftraight line under one common chimney.

1000 litres of water, holding in folution 50 kilograms of white purified calcined potafh, were poured into the receiver.

When the gas is difengaged by the muriatic acid, the raw materials are employed in the following quantities:

Oxyd

Oxyd of manganefe, - - - - -	24 kilograms.
Muriatic acid of 20 degrees of denfity, according to Baumé's aerometer, - - - - - - - - -	68
Total - -	92

making 11½ kilograms of ingredients to each of the 8 balloons.

The procefs commences by pouring 1000 litres of alkaline water into the receiver, which is then clofed by means of the ftopper or cork 8, and well luted. Each balloon is then placed in its fand-bath, the manganefe, well pulverifed, introduced, the muriatic acid poured upon it, and the corks, traverfed by the communicating tubes, inferted. Thefe are luted with paper fteeped in ftarch, and the luting is left to dry during ten or twelve hours, after which charcoal fires are lighted in the furnaces.

The diftillation continues ten or twelve hours. When it is completed, the tubes are unluted, the fire extinguifhed, and the balloons fuffered to cool in their refpective fand-baths, till the heat of the latter has diminifhed to 60 or 70 degrees, when hot water of the fame temperature is poured into the balloons. The refidue of the diftillation is therein diluted, after which the balloons are emptied, and left to cool in bafkets lined with ftraw. If this precaution of pouring hot water on the refidue were neglected, it would acquire fuch a confiftency, when the fulphuric acid is ufed, as we fhall prefently defcribe, that it could not be detached without great labour and danger of breaking the balloons.

When the gas is disengaged by the sulphuric acid, the following quantities are employed :

Oxyd of manganese, - - - -	25 kilograms.
Muriate of soda, - - - - - -	70
Sulphuric acid of 50 degrees of density, - - - - - - -	25
This acid is diluted with an equal quantity of water, or 16 litres, which reduces its density to 31 degrees.	
Total - -	120

The eighth part of which for each matrass is 15 kilograms.

The oxyd of manganese and the muriate of soda are pulverized and mixed; the matrasses are charged; and the operation is conducted as above described. This method is the most œconomical; first, because the sulphuric acid is cheaper than the muriatic, and, secondly, because from the residue after distillation may be extracted the soda contained in the muriate, which is now converted into sulphate of soda decomposable by well-known processes for the extraction of that salt. To measure the strength of these menstrua, and their activity in bleaching, we employed the solution of indigo recommended by Descroizilles, which is thus prepared :

Of concentrated sulphuric acid of 66 degrees of density, pour into a glass matrass -	7 parts by weight.
Of pulverized indigo - -	1

Agitate the mixture, and plunge the matrass half the depth of its globe in water rather more than

than tepid, agitating it from time to time. Two hours ſuffice to complete the ſolution, which is then diluted with 992 parts of water. This conſtitutes the ſolution for trial.

The ſtronger the bleaching-liquor is, the more parts of ſolution of indigo it will diſcolour; and by this teſt may be determined the quantities of each kind of bleaching-liquor to be employed, and mixed with water, to form baths or menſtrua in which the ſubſtance to be bleached is to be ſteeped.

One meaſure of the bleaching liquor, prepared in the manner above explained, generally annihilated the blue colour of 9 parts of ſolution of indigo uſed as a teſt. It was of the ſtrength of that of Javel, prepared by Alban.

Choice and Preparation of the Rags.

The tenacity of the paper depends on that of the fibres of the materials from which it is manufactured. Rags of new cloth and cordage produce a more tenacious paper than old rags. The former preſents alſo a greater variety according to the quality of the hemp or flax of which they are made. Rags of fine new cloth, whether brown or bleached by the oxygenated muriatic acid, are placed in the firſt claſs, and after theſe cordage and old rags.

Paper for bills of exchange, and other commercial or legal ſecurities, ought to be tenacious, that it may not eaſily be torn in conſequence of its thinneſs; materials of the firſt claſs ſhould be either wholly or principally employed for that purpoſe. The price given for it by the conſumers is amply ſufficient to afford the manufacturer a handſome

Fig. 3.

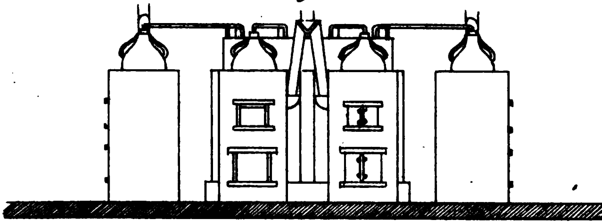


Fig. 2.

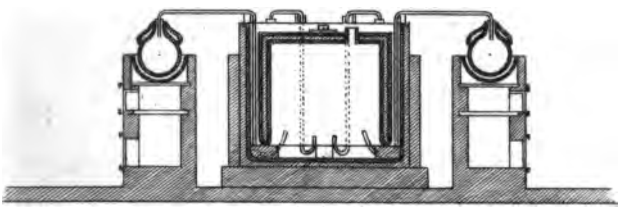


Fig 1.

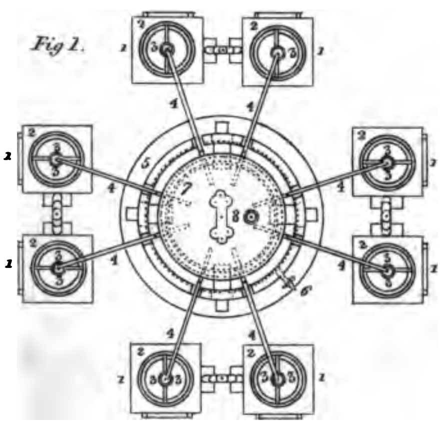


Fig. 4.

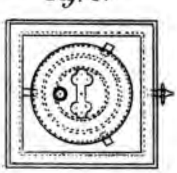
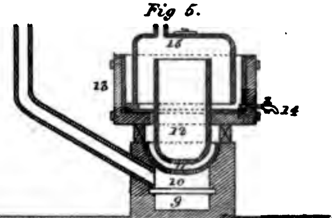


Fig 5.



handsome recompense for his industry and attention; this kind of paper being sold as high as 5 and 6 francs the kilogram.

The other kinds of paper also require more or less tenacity according to their respective thickness and the use for which they are intended; but whiteness is required in all.

The first operation to be employed on the rags is that of picking or sorting, in order to apply to each branch of manufacture the materials adapted to it. They are afterwards cut into pieces of about a decimetre square.

Suppose the object proposed is to produce a paper of a brilliant white. If it is to be thin, so that a ream for instance made in the form called *raisin* shall only weigh from 4 to 5 kilograms, that is, about one-third of the weight of the paper of commerce made in the same frame, the manufacturer may choose whether he will use new rags which are already of a fine white colour, or brown unbleached rags.

In the first case it is sufficient to pass them under the tearing cylinder, steep them in bleaching-liquor, then in a menstruum of sulphuric acid, as above described, grind them under the triturating cylinder during 7 or 8 hours, and, lastly, manufacture the pulp thus produced into paper.

In the latter case, that of using brown or unbleached rags, one of the following methods may be pursued.

The first, which will preserve to the paper all the tenacity of which it is susceptible, but is at the same time the most expensive, is to tear the rags, then to employ Berthollet's method of bleaching linen-cloth, namely, to steep them in

3 or 4 lixivia, then alternately in lixivia, in menstrua of bleaching liquor, and in sulphuric acid. By these operations the weight of the raw materials is reduced 40 a 45 *per cent.*

This was the first method we employed for the assignat-paper; but we soon perceived that almost all the lixivia, and most of the menstrua of liquor, might be spared, still preserving, however, all the tenacity requisite in that kind of paper; for which purpose it was only needful to cause the rags to undergo more or less fermentation, by suffering them to lie in the fermenting vat. During this operation the colouring matter undergoes a slow combustion, passes into a kind of saponaceous state, and is carried off with the water by washing the rags under the tearing cylinder. One lixivium, two menstrua of bleaching-liquor, and one of sulphuric acid, are then sufficient completely to bleach the brown rags or the cordage. This is the second method.

We were at that time unacquainted with the œconomical processes of Chaptal in lixiviating operations. Doubtless manufacturers will not fail to employ them in future; but the use of the fermenting vat, properly conducted, will always be very advantageous.

Lastly, if the rags are neither quite white nor quite brown, but in an intermediate state, they are left a shorter time to ferment, as for instance from twelve to fifteen days, till the heat produced by the fermentation causes the thermometer to rise to 30 or 35 degrees of Raumur; the rest of the process being conducted as in the preceding cases.

Composition of a Menstruum of Bleaching-liquor for a Parcel of unravelled Rags, weighing 50 Kilograms.

For each parcel let a certain number of wooden troughs (for instance eight or nine) capable of holding jointly 600 litres of water, be placed in a line. Into these vessels pour 450 litres of clear water, adding 90 litres of bleaching-liquor, and dividing the whole equally between all the troughs; then immerge in each an equal portion of the 50 kilograms of unravelled rags during twelve hours, agitating them from time to time; wash them completely in clear water, and steep them in a menstruum of sulphuric acid, composed as follows:

Menstruum of sulphuric Acid.

Water, - - - - - - - -	200 litres.
Acid of 50 degrees of density, -	3 kilograms.

This menstruum gives nearly 4 degrees of Baumé's aerometer.

The immersion should continue from forty-five minutes to an hour. The rags are then perfectly washed in clear water, and passed under the triturating cylinder, after which the stuff is ready for use.

If the activity of the bleaching-liquors be not exhausted by the rags steeped in them, of which trial is made by the solution of indigo, they are again employed on other rags, which exhaust it completely; the rags being themselves afterwards saturated by a fresh liquor.

Such was the state in which we left this new art in the year 3. Since that period Mr. Welter, to whom chemistry and the arts are indebted for

a great number of ingenious apparatuses, has simplified that which he had invented for the preparation of the bleaching-liquor. He found, for instance, that in lieu of three vessels in the receiver two were sufficient even for the simple liquor which contains no fixed alkali.

It has been already stated, that we were obliged to make use of an alkaline solution in the receiver to obviate the smell otherwise produced by agitating the rags in the liquor. The alkali, it is true, had fulfilled our object in this respect; but the cost of this salt, added to its weakening the bleaching-liquor, had more than doubled our expenses. If this difference in the cost of the liquor was of little importance considering the object we had in view, it is not so with regard to the common operations of the paper-manufacture, in which no means of œconomy should be neglected. Thus Mr. Welter has found that the inconveniences attending this liquor may be easily obviated by not agitating the cloth or rags in open vessels, but exactly closing them with well-fitted covers, and agitating them by means of a fan within, turned by a winch without.

Estimate of the Expense of the simple Bleaching-liquor made with sulphuric Acid, which is the most œconomical Method.

The receiver is supposed to hold 1000 litres of water.

	fr.	ct.
Oxyd of manganese, 25 kilograms, cost at the most, - - - - - - -	15	0
Muriate of soda, 70 kilograms, at 10 c. ci.	7	0
	22	0

Sulphuric

	fr.	ct.
Brought forward - - - -	22	0
Sulphuric acid, 25 kilograms, of 50 degrees of denfity, at 1½ fr. - - - -	37	50
3 days labour of the foreman, at 3 fr. -	9	0
3 ditto ditto, of a journeyman, at 1½ -	4	50
Fuel, about - - - - - - - - - -	3	0
Wear and tear, and incidents, - - - -	6	0
Our apparatus coft us, 2072 fr. in affignats in the year 2, equal to 622 fr.		
Carriage and fitting up - - - 378		
Coft of the apparatus - - 1000		
The intereft of which, at 10 *per cent.* is 100 fr. which at the faid rate of 100 fr. *per ann.* amounts *per* diftillation to -	1	0
Total - - - -	83	0

Thus a litre of bleaching-liquor would coft 0.083 fr. or, in round numbers, 9 cents.

Eftimate of the additional Expenfe of the Operation of bleaching on 50 Kilograms of Pulp, reckoning one immerfion in Bleaching-liquor, and one in ful-phuric Acid, as moft ufually practifed.

	fr.	ct.
90 litres of bleaching-liquor, at 9 cents. *per* litre, - - - - - - - - - -	8	10
3 kilograms of fulphuric acid at 1½ fr. -	4	50
Labour, - - - - - - - - - - - -	0	50
Total - - - -	13	10

Which amounts, *per* kilogram of paper, to an expenfe of 0.262 fr. or about 27 cents.

The

The ordinary paper of commerce is generally sold from 1 fr. 30 c. to 1 fr. 40 c. *per* kilogram; whereas, with an addition of only 27 cents for the process of bleaching, it obtains a preference before that sold at 3, 4, and even 5 francs, and which can only be procured in small quantities on account of the difficulty of picking out the materials from more ordinary rags. There is, therefore, no doubt that the above-described methods must cause a great diminution in the prices of the fine papers. They are principally advantageous when applied to thin paper, because the expenses of bleaching are always in an inverse ratio to the weight of the materials employed.

I shall close these observations with a description of an apparatus, invented by Mr. Athénas, for preparing oxygenated muriatic acid, which he very obligingly showed, and even lent to us. This apparatus is remarkable for its simplicity, neither requiring balloons of earthen-ware or glass, nor intermediate vessels, nor communicating tubes.

Fig. 4 represents a horizontal, and Fig. 5 a vertical, section. An explanation of the latter will give a sufficiently accurate idea of the whole.

9. The ash-hole of the furnace.

10. The fire-place, the chimney of which is bent on one side.

11. An iron pot, containing boiling water, to serve as a bath to the body, and effect the disengagement of the gas.

12. A leaden vessel, serving as a body, in which the materials under operation are placed.

13. A tub, lined with lead, traversed by the vessel 12, with which it is soldered.

14. A

14. A cock for drawing off the liquor after the procefs is completed.

15. A leaden receiver inverted in the tub. This veffel may have a hole, to let off the atmofpheric air when it is plunged into the tub, afterwards corking the hole previous to the difengagement of the gas. This receiver refts on three wooden brackets, in order to keep it fomewhat elevated above the bottom of the tub.

If we compare the ftrength of the liquor obtained by this apparatus with that by ours, we fhall find that with equal proportions of ingredients, and of water in the receiver, its difcolouring power on the folution of indigo is only about half as great as in ours. Thus there is a real lofs of ingredients, which muft be attributed to the fmall degree of heat they receive in the water-bath, which is infufficient to extract all the gas. I thought it however ufeful to make known this ingenious machine, the fimplicity of which will attract the attention of chemifts. The reader will, however, perceive that it is capable of improvement, whether by adding on one fide a feparate furnace with a fand-bath and balloon as ufual, in order afterwards to conduct the gas under the receiver through a leaden pipe, or by an alteration in its arrangement, fubftituting in lieu of the water-bath fome other, whether liquid or dry, capable of containing and communicating a greater degree of heat, provided it be not fo great as to melt the lead; fuch heat being fufficient for difengaging the gas.

XXXIII. *List of Patents for Inventions, &c.*

(Continued from Page 72.)

Naphtaly Hart, of Pimlico, Middlesex, Gentleman; for an instrument or goniometer which will measure or lay down angles to minutes, from the smallest radiuses to any extent, draw circles to any radius, draw and measure all kinds of right-lined figures made use of in geometry, trigonometry, and navigation, with an accuracy and dispatch hitherto not known, which instrument he calls the Hartesian Goniometer, and a clamp applicable thereto, and to other useful purposes; and also a new suspensor and orbicular castor, applicable to maritime and other purposes. Dated December 3, 1801.

James Boaz, Manufacturer in Glasgow; for a new and improved method of communicating thoughts, information, and intelligence, to and from different places, at a distance from each other, by means of signs, by lights and otherwise. Dated December 3, 1801.

Lawrence Collin, of King-street, Portman-square, St. Mary-le-Bone, Middlesex, and James Butters, of Wigmore-street, Cavendish-square, in the same parish, Turner; for a machine for saving persons, though ignorant of the art of swimming, from drowning, which they propose to call a *Collinette*. Dated December 3, 1801.

Charles Grierson, of New Bond-street, in the parish of St. George, Hanover-square, Middlesex, Gun-maker; for a breech and lock for single and double-barrel guns, pistols, and other fire-arms, on a new and improved principle. Dated December 19, 1801.

Printed by Nichols and Son, Red-Lion-Passage, Fleet-Street.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XCIV.

Printed by Nichols and Son, Red-Lion-Paſſage, Fleet-Street.

XXXIV. *Specification of the Patent granted to Mr.* John Walker, *of Tufton-ſtreet, in the Pariſh of Saint Margaret, within the City and Liberty of Weſtminſter, in the County of Middleſex, Army Accoutrement-maker, and* Godfrey Alphey, *of Peter-ſtreet, in the ſaid Pariſh of Saint Margaret, within the City and Liberty aforeſaid, Painter; for making and manufacturing Caps and Hats, and rendering them perfectly water-proof; as alſo all Kinds of Leather, Silks, Linen, Cotton, Stuffs, Paſteboard, and other Manufactures and Subſtances, for the Purpoſe of being worked up into Boots, Shoes, Gaiters, Women's Hats or Bonnets, and other Wearing-Apparel, ſo as to be uſed on all Occaſions, where a Power of repelling Wet or Moiſture may be required.*

Dated November 3, 1801.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that we the ſaid John Walker and Godfrey Alphey, in compliance with the ſaid proviſo, in the ſaid letters patent mentioned and contained, do hereby declare, that the nature of our ſaid invention, and the manner in

which the ſame is to be made and performed, is particularly deſcribed and aſcertained in the following ſpecification, or manner hereinafter mentioned; that is to ſay: In and for the making and manufacturing of our new-invented caps, which are principally intended for the uſe and wear of the military, we take a ſuitable piece or pieces of manufacture, called paſteboad, and cover both ſides thereof with linen-cloth, or any other texture wrought in a loom, which we cement thereto by glue or paſte, or paſte and glue mixed, out of which the cap is then cut and ſhaped on a block, or otherwiſe, according to the ſhape and faſhion the ſame is ordered to be made, and as circumſtances may require. The ſeams or joinings of the paſteboard are united by ſewing, and by glue or paſte, or paſte and glue mixed; and alſo by ſlips of leather, linen, or other wove texture, glued or paſted over the ſame, both inſide and outſide, where found neceſſary. It is then painted, both inſide and outſide, with any kind of oil-paint, or oil and lamp-black, (which latter is greatly to be prefered,) with one or more coats, as circumſtances may require: when this is dry, it is then to be covered with one or more coats of japan or varniſh, mixed with lamp-black or ivory-black. The peak or rim of the cap, together with the cape behind, agreeable to the quality and faſhion ordered to be made, is alſo to be painted, japanned, or varniſhed, on one or both ſides, as may be thought neceſſary, in like manner as the other parts of the cap are. When the peak or rim, together with the cape and lining, are affixed to the crown, in the uſual manner, the cap is then finiſhed, excluſive of any ornament or ornaments that may be

thought

thought proper to affix to the ſame. The men's hats are made in the ſame manner, and with the ſame materials as the crown of the cap, except being principally covered with ſilk, linen, cotton, or other texture, wrought in a loom cemented to the paſteboard in like manner as deſcribed for the cap. And alſo except that ſuch breadth is given to that ſide or inner part, or edge of the flap, or rim, that is next the crown, as will admit of its being notched and turned up, ſo as to lie cloſe to the ſide of the crown, and is to be united thereto by ſewing. And with the ſame cement as applied to the cap and other articles, the parts ſo turned up, ſewed, and cemented to the crown, are to be covered with leather, or any texture wove in a loom: the whole is then to be painted, japanned, or varniſhed, on one or both ſides, as may be thought proper, and in like manner as the caps. The preparation of leather for boots, ſhoes, gaiters, or other articles where a power of repelling wet is required, is to be painted, japanned, or varniſhed, in like manner as the caps are, on one or both ſides as may be found neceſſary. When this operation is performed upon leather, it muſt be upon ſuch leather only which has not been dreſſed with oil, or any other greaſy ſubſtance. The preparations of paſteboard, and ſilk, linen, cotton, ſtuffs, or any other texture wrought in a loom, for the purpoſe of making ſhoes, gaiters, women's hats or bonnets, are to be painted, japanned, or varniſhed on one or both ſides, as may be found neceſſary in like manner as the caps are herein-before ſpecified to be done. In witneſs whereof, &c.

XXXV. *Specification of the Patent granted to Mr.* William Jackson, *of Easingwold, in the County of York, Gentleman; for a Machine or Drill for drilling or sowing Turnips, to be fixed to a Plough-beam.*

Dated November 3, 1801.

WITH A PLATE.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said William Jackson declare my said invention to be according to the following description.

Fig. 1, (Plate X.) consists of a brass plate or frame, wherein the brass roller A is fixed with two caps and screws at B, B. The brass roller hath three, four, or more sets of holes, consisting of different numbers, *viz.* from six to eighteen in each set or circumference.

Fig. 2, is a sliding cover, whose inside closely fits the roller A. The opening B moved over any of the different numbers of holes, and screwed fast by the two screws A, A, in one revolution will discharge different numbers of seeds. The row of holes with six in it will sow the seed at sixteen inches distance from each other; and the row with eighteen holes in it will sow the seed five inches distance from each other: but the holes may be varied in their numbers, at the will of a purchaser. At C is a brass screw, hollowed at the lower end, and cemented, full of horse-tail hair, and of the diameter of the aperture B, in the centre of Fig. 2.

Fig.

Fig. 3, is a ſection of Fig. 2, with the ſeed-box upon it.

Fig. 4, A, is a ſliding bar of wood, two feet long, two inches broad and one inch and a half thick. B, is a caſt-iron or wood wheel, thirty-one inches diameter, and faſtened by a ſquare hole and nut upon the end of the iron axletree C, which axletree runs, and is fixed, to the ſliding-bar A, by the two collars at D, D. The axletree hath a ſquare hole in the end at E, where it receives the ſquare end of the arbor E, in Fig. 1. F F F, is the ſide view of the ſeed-box ſpout, and fixing to the end of the ſliding box, by means of the cock E, part of the plate or frame, as at D, in Fig. 1, is ſcrewed, ſo as to be in a direct line with the axletree of the wheel B. G, is a ſliding cap or box, through which the ſliding-bar A moves backwards and forwards from D to D, and may be fixed in any part between, to ſuit the breadth of the furrow intended to be ploughed, through the upper part of the ſame. The wood frame B, Fig. 6, ſlides likewiſe to and fro, and may be fixed by the ſame ſcrew, (H, Fig. 4); by which motion the ſeed may be dropped either under the furrow or upon the ſurface of the ground.

Fig. 6, A, the ſtud to go through the plough-beam as near the coulter-hole as convenient, on the left-hand ſide of the beam. The frame B, two feet ſix inches in length, and three inches ſquare, ſlide through the box or cap as at I, in Fig. 4. At E, the wheels, axletree, and the arbor of the drill-roller, join and couple by means of a male and female ſquare, or an univerſal joint.

Fig.

Fig. 7, A, the stud, as at A, Fig. 6, to put through the plough-beam, as near the coulter-hole as convenient, on the right-hand side. The same frame B, Fig. 6. The same drill F and wheel B as described in Fig. 4.

Figs. 8, 8, is a frame with two arms and two bolts, as at A A. The upper part of the wheel's axletree goes through the arm and frame at B, and rises and falls to suit the depth you plough, secured by the screw C, and in some measure answers the purpose of a single-wheel plough. The same wheel, and the same drill, as described above, upon each centre or contrate wheel, are fixed of equal sizes; and a rolling-shaft D, with a nut upon each end to suit each wheel: and, by varying the numbers of the nuts upon the shafts, you vary the quantity of seed to be sown. This drill may be used advantageously in sowing of rape and other small round seeds.

In witness whereof, &c.

We are desired to add, that the above machines are manufactured and sold (under the appointment of the Patentee) by Mr. John Jackson, of Boroughbridge, and Mr. Richard Scurr, of Thirsk, Yorkshire, at 1 *l.* 11 *s.* 6 *d.* each.

One of the machines may be seen at the Office of this Publication, where orders may be addressed.

XXXVI.

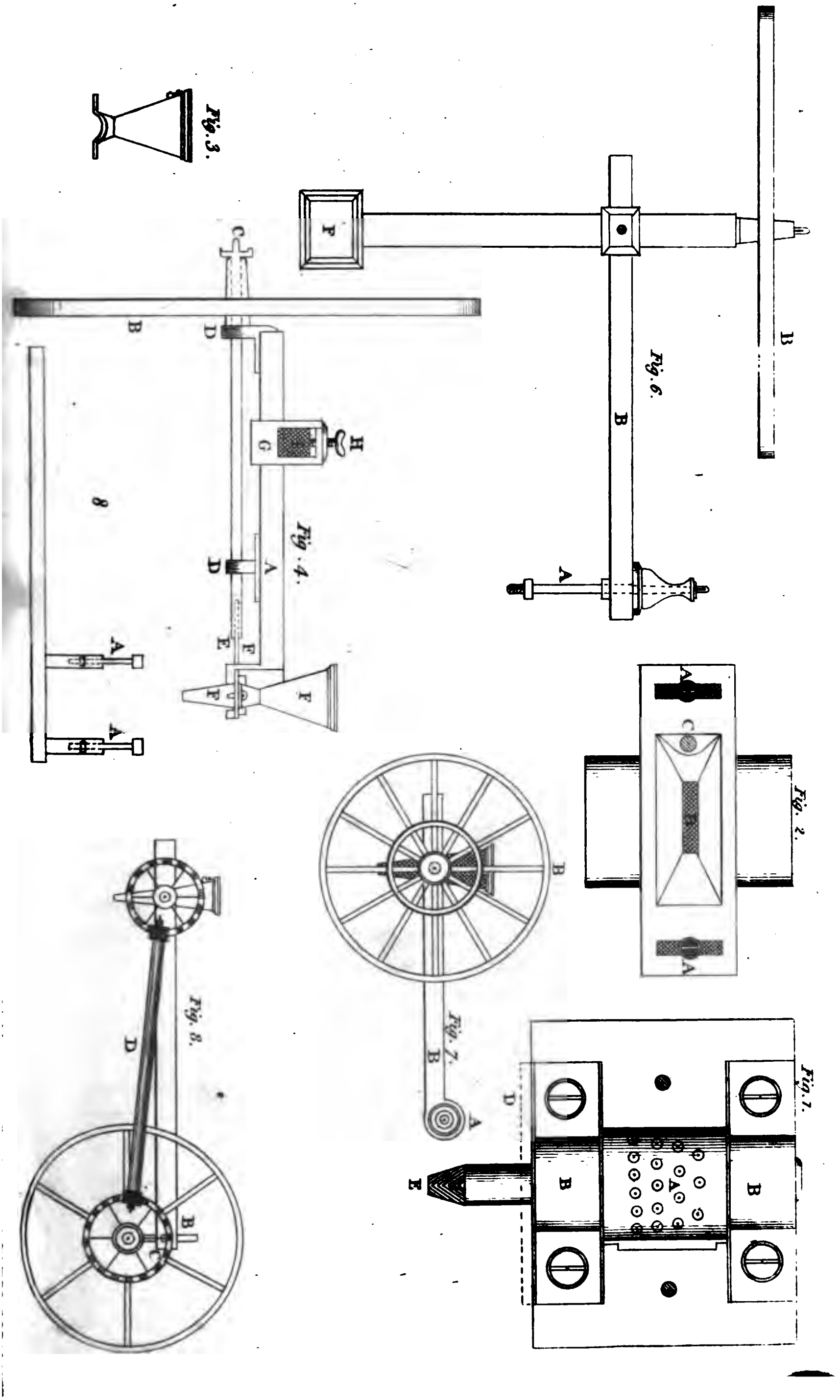


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 6.
Fig. 7.
Fig. 8.
A
B
C
D
E
F
G
H

XXXVI. *Specification of the Patent granted to Mr.* JAMES BOAZ, *Manufacturer in Glasgow; for a new and improved Method of communicating Thoughts, Information, and Intelligence, to and from different Places, at a Distance from each other, by Means of Signs, by Lights and otherwise.*

Dated December 3, 1801.

WITH A PLATE.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said James Boaz, in compliance with the said proviso, in the said letters patent contained, and the purport and true intent and meaning thereof, and of his Majesty's said most gracious intentions, do, by this instrument in writing, under my hand and seal duly executed, describe and ascertain the nature of my said invention, and in what manner the same is to be performed, as follows; that is to say: My invention consists in representing, at pleasure, by means of lights or luminous bodies, and also by means of opaque bodies, or by means of both combined, any letter of the alphabet, or any numerical figure, or any appearance or appearances which it may be desirable to exhibit as a sign, symbol, or signal, such as a circle, a semicircle, a segment of a circle, a square, one side of a square, or two or three sides of a square, a cross, a triangle, and other such like. This may be effected in various ways, and a smaller or larger number of lights or bodies; but perhaps, in regard to luminous bodies, and where correct circular appearances are not necessary to be represented, as simple a mode as any is the following. Take five

five and twenty lamps, dispose of them on a board or frame, so as to form a square; that is by fixing them in five rows, and five lamps in each row, at equal distances from each other. Affix a cover or blind (made of any opaque substance) before each lamp, of a round or rather an oval shape, having a handle or neck made so as to move backwards and forwards, or up and down, round a pin, nail, or pivot, fixed in the board or frame. Fix a small line (made of small twine or rope, according to the size of the machine, or of catgut, or a small metal chain, or any other pliable and connecting substance) around the handle or neck of each of these covers or blinds. Connect each of these lines with a pulley at one side of the board or frame. Raise this board or frame perpendicularly upon a square or oblong frame. Fix in this last square or oblong frame as many thin oblong pieces of wood or metal as there are lamps and lines attached to them; such thin or oblong pieces of wood or metal moving upon two pivots in the side of the square or oblong frame in which they are placed; and these thin or oblong pieces of wood or metal being placed in their frame in such manner as that their oblong direction may run from side to side of their frame upon the pivots fixed on which they move, and so that each of these thin oblong pieces may, when not pressed upon as after-mentioned, remain perpendicular to its frame, and all of them, when at rest, may be parallel to each other. One of the lines affixed to the lamp-covers, or blinds, and connected with its pulley, being fixed to the upper edge of one of these thin oblong pieces of wood or metal, that is, the one extremity of such line being affixed

to the handle or neck of the lamp-cover, or blind; and the other extremity being affixed to the upper edge of one of the thin oblong pieces of wood or metal; then, upon turning the thin or oblong pieces of wood or metal, so as to make it incline, the lamp-cover, or blind, will be drawn up; and by thus making as many of the thin oblong pieces of wood or metal incline as lamps are wanted to be uncovered, the letter of the alphabet or figure wished to be represented will be made to appear. In order the more easily to give the necessary inclination or turning to these thin oblong pieces of wood or metal, (which, seeing they act by their inclined positions, shall be called incliners,) place a piece of wood or metal, nearly of the same size with the incliners, so as to be easily moved backwards and forwards (in grooves for example) in the frame in which the incliners are placed at right angles to them, and so that the upper edges of such pieces of wood or metal may come near to the under edges of the incliners. By fixing in such pieces of wood or metal pins or teeth, (made of wood or metal,) the piece of wood or metal having such pins or teeth being pushed in, (and which shall be called the pusher, seeing it acts by being pushed in,) the pins or teeth which are fixed in it striking against the under edge of the incliners, give them the inclined direction which is necessary to pull the lines affixed to the lamp covers; and thus, by affixing in each of these pushers as many pins or teeth as lamps are meant to be uncovered, and so that these pins or teeth may strike against the under edge of the incliners, (connected as they are by means of lines and pullies with the covers, or blinds of the lamps meant to be uncovered,) as

many lamps will be uncovered as are neceſſary to repreſent the letter of the alphabet, or other ſign or appearance meant to be exhibited; and, by having a double ſet of lamp-covers or blinds, and lines and pullies, that is, by having lamp-covers or blinds behind as well as in front of the board or frame, and lines and pullies, to connect them with the incliners in the ſame manner as the covers and blinds in front are connected with the incliners, the ſame lamps may be rendered viſible behind, which are made viſible in front, of the board or frame; or other lamps may be rendered viſible behind, which are not made viſible in front, of the board or frame. Upon drawing back the puſher the lamp-covers or blinds fall down by their own weight, and cover the lamps, and the incliners alſo reſume their former poſition. For the greater facility and eaſe in producing the deſired effect, there may be a puſher, having pins or teeth fixed therein as aforeſaid for each letter of the alphabet, and for each numerical figure or other ſign or appearance wiſhed to be repreſented, and theſe puſhers may farther be marked on the outſide of their frame, from whence they are puſhed in, with the letter of the alphabet or numerical figure, or other ſign or appearance, which, upon being puſhed in, they repreſent by means of the lamps which they uncover; and a handle or knob may be fixed to the end of the puſher at which the letter or figure, or ſign, is marked, for the greater convenience in puſhing it in and pulling it back; and the letter, figure, or ſign, may be marked upon the handle or knob. Cranks will do equally well as the thin oblong pieces of wood or metal, which form the incliners to which the lines are attached, which connect them with

the

the lamp-covers or blinds; but thin oblong pieces of wood or metal are ſuggeſted as being more ſimple in their configuration and conſtruction; and theſe thin oblong pieces of wood or metal, or cranks, acting as incliners, may be placed in a perpendicular as well as in a horizontal direction. Inſtead of lines and pullies, the lamps too might be uncovered, and again covered, by means of wires and keys preſſing upon them, as in a piano forte: but lines and pullies are ſuggeſted, as being more ſimple in their conſtruction, and leſs liable to go out of repair. Various other modes of conſtruction might alſo be eaſily adopted to produce the ſame effect. For inſtance, in place of having lamps with covers or blinds, and lines and pullies, and incliners and puſhers, the lamps might be made with an opaque and a ſhining ſide; and by means of a ſcrew or ſcrews, as well as by means of lines and pullies, the lamps may be made to turn, ſo as to exhibit their opaque or their ſhining ſide that is to be made viſible or inviſible at pleaſure. In order to comprehend this invention the more diſtinctly, a drawing is annexed (Plate XI. Fig. 1.) agreeably to the deſcription firſt given, in which the machine is ſuppoſed to repreſent the letter H. The black ſquare repreſents the board or frame behind which the lamps are placed, having a hole or aperture, through which each lamp ſhines; that is, having as many holes or apertures in it as there are lamps affixed behind it. The oval figures (*a*) repreſent the lamp-covers or blinds. The lines repreſent the lines attached to the lamp-covers and incliners. The five dots at the bottom of the black ſquare repreſent the

 pullies

lamp may be ſo placed or ſuſpended as to pro-duce a ſimilar effect upon mirrors or reflectors, which might be covered or uncovered at pleaſure, as the lamps above mentioned. It is alſo obvious, that almoſt any form, figure, or ſhape, may be repreſented by the diſpoſition or arrangement of lamps or luminous bodies, rendered viſible or in-viſible at pleaſure, in the manner that has been deſcribed. But it is farther obvious, that by combining the repreſentations of two or more let-ters or figures together, as many different varie-ties of ſigns or appearances may be produced as there are combinations of letters or figures, which may be repreſented ſeparately. In order the more eaſily to comprehend the form of the lamp-co-vers or blinds above deſcribed, two drawings are given of the ſame in the annexed paper of draw-ings, *viz.* Fig. 5, in which a front view of the lamp-cover is ſeen, with its line attached to it, and Fig. 6, in which a ſide view is given of it. A drawing is alſo given in the annexed paper of drawings of the incliner, *viz.* Fig. 7. The whole figure taken together repreſents the incliner as made of a thin piece of wood or metal. The black part of it repreſents the crank, which may accompliſh its purpoſe equally well with the thin piece of wood or metal. A drawing is alſo given in the annexed paper of drawings, *viz.* Fig. 8, of a ſmaller frame, in which the lamps may be firſt fixed, which ſmaller frame may be eaſily made to ſlide into a caſe, or in grooves behind or be-fore, or may be otherwiſe attached to the larger frame in which the lamps are placed in the rows in which they are wanted. The drawing marked Fig. 13, in the annexed paper of drawings, ſhews the manner in which the puſhers may be placed

in

in their frame, running in grooves or cases. The whole machine may, for the sake of preservation, be inclosed in a box or case, which box or case may, for the sake of convenience, run on castors; and the machine may be raised to the top of its box either by means of a pulley or by the hand, if of small dimensions. A representation of the machine and its box is given in Fig. 10, of the annexed paper of drawings, shewing a front view of the ends of the pushers, and a lateral view of the lamps. The description hitherto given relates to the modes by which any letter of the alphabet, and any numerical figure, or any appearance or appearances necessary to be used, as signs, signals, or symbols, may be effected by means of lamps or luminous bodies. I now propose to shew how these effects may be produced by means of opaque bodies. For this last purpose, take a frame, having bars or divisions, running either in a perpendicular or horizontal direction in the frame. For instance, take a square or oblong frame, having four rims or sides; place horizontally in it five bars or divisions; place at equal distances, on each of these bars, five boards, or thin pieces of wood or metal, of any shape or size, thinner than the bar to which they are to be attached, leaving a space between each board or piece of metal. When the boards or pieces of metal are parallel to each other, and present their edge or thin side to the front of the frame or bars, they are not seen at a distance; the whole exhibiting at a distance only the appearance of the bars. The boards may be so constructed as always to remain of themselves in this position; that is to say, let the boards be fixed, by means of pivots or hinges, to the upper side of the front

of

of the bars; the pivots or hinges being placed on the board, not at its middle, but near one edge of it, ſo that the greater weight of that part of the board, the edge of which is fartheſt from the hinges or pivots, would bring that part of it downwards, and make the board hang perpendicularly, were it not for the bar below, to which it is attached; which bar below being made broader, or as broad as the breadth of that part of the board, the edge of which is fartheſt removed from the hinges or pivots, catches ſuch part of the board, and, keeping it in an horizontal poſition, prevents it from falling, as it otherwiſe would do, to its perpendicular. In order to raiſe the board, fix to it, in that part of it, the edge of which is leaſt removed from the hinges or pivots, a line, (made of twine or rope, or other pliable ſubſtance, according to the ſize of the machine,) and connecting it with a pulley at the under part of the frame, affix the extremity of ſuch line to the upper edge of the incliner as in the preceding part of the deſcription. The puſher upon being puſhed in, will produce its effect as in the former part of the deſcription, by bringing the incliner to its inclined poſition, which will raiſe the board with which it is connected by the line and pulley, as above mentioned; and here, as in the former caſe, there being an equal number of boards and lines, and pullies and incliners, and as many puſhers as there are letters, numerical figures, or ſigns, meant to be repreſented; the letter, numerical figure, or ſign, wiſhed to be repreſented, may be exhibited at pleaſure by the opaque body in the ſame manner as by the luminous body, by puſhing in the puſher, and, upon pulling back the puſher, the boards

Fig.

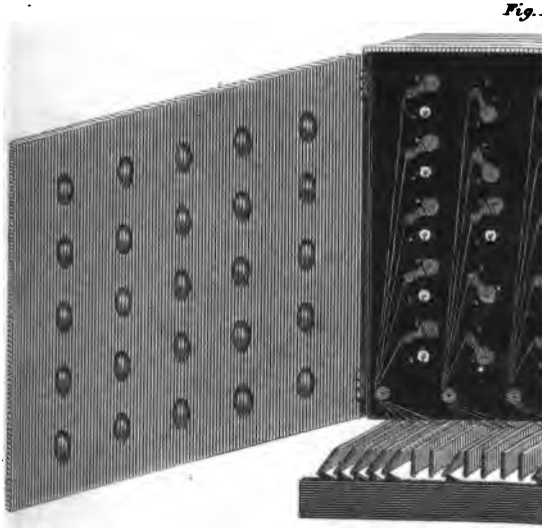


Fig. 4.

Fig. 5.

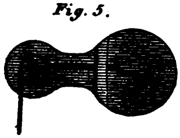
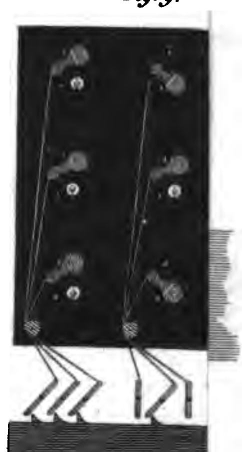


Fig. 7.

Fig. 6.

Fig. 8.

Fig. 9.



ards will fall down by their own weight, and e incliners will then alſo reſume their former ſitions. The ſame effect may be produced by aking each board turn horizontally on a pivot, the horizontal bars; and in order to turn each bard ſo as to make it preſent its flat ſurface or s thin edge at pleaſure, to the front of the frame r bars, let a ſmall wheel be fixed to the pivot; e edges of which wheel may be grooved, the etter to keep the lines to be attached to them in eir proper poſition. Affix at oppoſite ſides of e groove in this wheel the ends of two lines, o that the one line upon being pulled will turn the wheel one way, and the other line being pulled will make it turn the other way. Paſs theſe lines, the ends of which are ſo fixed in the groove of the wheel through two pullies, placed in ſuch manner on the bars as that the lines may be pulled oppoſite ways. The lines dropping to the bottom of the frame or bars will then be paſſed through two correſponding pullies at the bottom thereof; and the end of the one line being fixed to the upper edge of the incliner, and the end of the other line being fixed to the under edge of the incliner, the incliner, upon receiving its inclined poſition, by means of the puſher, will turn the board ſo that its flat ſurface or its thin edge may be preſented to the front of the frame or bars at pleaſure. And in this conſtruction there being no other means to make the boards reſume their firſt poſition, the under edge of the incliner ſhould, in this mode of conſtruction, be made heavier than the upper, ſo that the puſher being pulled back, the weight of the under edge of the incliner may bring it to its perpendicular poſition,

 and

and thus turn the board to its original poſition. For the ſake of ſtrengthening the frame in which the boards are placed, perpendicular as well as horizontal bars may be uſed and fixed together as they paſs each other at right angles. And it may be eaſily perceived, without any particular deſcription, how the boards may be moved by means of pivots placed in the perpendicular bars, or be made to move round the perpendicular bars connected with the incliners by means of lines and pullies, in the manner which has been mentioned. What has been hitherto ſtated regards the modes by which any letter of the alphabet, or any numerical figure, or any appearance or appearances neceſſary to be uſed as ſigns, ſignals, or ſymbols, may be repreſented by means of lamps or luminous bodies, or by means of opaque bodies ſeparately. But I now propoſe to ſhew how theſe effects may be produced by means of luminous bodies and opaque bodies combined. For this purpoſe apertures muſt be made in the boards above deſcribed, and lamps muſt be placed in the apertures of the boards, in ſuch manner as that the lamps remaining ſtationary do not interfere with the movements of the boards. This may be effected by means of a ſmall ſeat or reſt attached to the bar to which the boards are fixed, as repreſented in Fig. 12 of the annexed paper of drawings. The flame or light of the lamp will then be ſeen through the aperture of the board when its flat ſurface is preſented to the front of the frame or bars; and, in order to prevent the flame or light from being ſeen when the thin edge of the board is preſented to the front of the frame or bars, let a thin piece of wood or metal,

rather

rather larger than the aperture in the board (as represented in Fig. 11 of the annexed paper of drawings) be fixed at right angles to the board below the aperture, ſo that when the thin edge of the board is preſented to the front the thin piece of wood or metal is raiſed up, and hides the lamp; and thus the lamps are viſible through the apertures of the boards only when the flat ſurfaces of the boards are preſented to the front of the frame or bars. In order that the nature of this invention may be the better underſtood, a drawing is given in the annexed paper of drawings, *viz.* Fig. 2, of the machine, as ſhewing its combined effects by means of opaque and luminous bodies. The drawing, as in the firſt part of the deſcription, repreſents the machine as forming the letter H. The lines in this drawing, running perpendicularly and horizontally, exhibit the frame and bars. The black ſquares repreſent the boards, with their flat ſurfaces in front of the frame or bars, forming the letter H. The ſmall white oblong ſpaces in theſe black ſquares repreſent the apertures in them, through which the light or flame of the lamps is ſeen. The ſmall white lines appearing under theſe white oblong ſpaces, repreſent the thin edges of the thin pieces of wood or metal which cover the lamps when the thin edge of the boards is in front of the frame or bars. The black oblong figures repreſent the boards, having their thin edges in front of the frame or bars. The ſmall elevations riſing from theſe black oblong figures, ſhew the thin pieces of wood or metal which hide the flame or light of the lamps when the thin edge of the boards is in

 from

front of the frame or bars. The lines repreſent the lines fixed to the boards and incliners, connected by their pullies. The dots at the bottom of the bars repreſent theſe pullies. The figures (*b*) immediately under theſe dots repreſent incliners; and the black oblong figure at the bottom of the whole repreſents the puſher, with its teeth or pins, which producing its effect upon the incliners connected with their lines and pullies with the boards, exhibits, by means of the boards or lamps, or both combined, the appearance of the letter H. Two drawings are alſo given, in the annexed paper of drawings, of a board, with its lamp turning horizontally upon a pivot, *viz.* Fig. 3 and Fig. 4. Fig. 3, repreſents a front view of the board and lamp, ſo that when the flat ſurface of the board is in front, the flame or light of the lamp is viſible. Fig. 4, repreſents a ſide or lateral view of the board and lamp, ſo that when the thin edge of the board is in front, the light or flame of the lamp is inviſible; and the lamp, according to this mode of conſtruction, is fixed in the board, and turns with it. Theſe ſame figures, *viz.* Figs. 3 and 4, alſo ſhew that lamps, with an opaque and a ſhining ſide, mentioned in a previous part of this deſcription, may be made to turn by means of lines and pullies, ſo as to exhibit their opaque or their ſhining ſide that is to be made viſible and inviſible at pleaſure. And the ſaid paper of drawings hereunto annexed is ſigned by me as relative hereto. In witneſs whereof, &c.

XXXVII.

XXXVII. *Specification of the Patent granted to Mr.* HENRY BROWNE, *of Derby, in the County of Derby, Chymist; for a Method of making and preparing Extract of Zinc.*

Dated May 28, 1799.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Henry Browne do hereby describe and ascertain the nature of my said invention, and that the same is to be performed, as follows; that is to say: The extract of zinc is made or composed of the vegetable or animal acid, saturated with the oxyd of zinc, in whatever state it may be found, whether in the state of ore, as calaminaris of every description, blend, or black-jack, or by whatever other name it may be called, or in the state of flowers, or soot from furnaces, where brass or spelter is made, called tutty-pompholix, or oven-bruck, or the flowers or oxyd, made directly from the ore, or in its metallic state, by heat, or any kind of acid. The acid necessary for this purpose may be made by acetous fermentation, as common vinegar, either in its natural or distilled state, or any acid produced from any vegetable, by chemical acid, or any vegetable or animal oil, whether disengaged by any process, or used in the state of oil; all or any of the above being saturated with the oxyd of zinc, produce extract of zinc. In witness whereof, &c.

XXXVIII. *Method of preserving fresh Water sweet during long Voyages.* *By* SAMUEL BENTHAM, *Esq. of Queen's-square, Westminster.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Gold Medal was adjudged by the Society for this Communication.

THE mode in which I conceived fresh water might be preserved sweet, was merely by keeping it in vessels of which the interior lining at least should be of such a substance as should not be acted upon by the water, so as to become a cause of contamination. Accordingly, on-board two ships, the greater part of the water was kept, not in casks but in cases or tanks, which, though they were made of wood, on account of strength, were lined with metallic plates, of the kind manufactured by Mr. Charles Wyatt, of Bridge-street, under the denomination of tinned copper-sheets; and the junctures of the plates or sheets were soldered together, so that the tightness of the cases depended entirely on the lining, the water having no where access to the wood. The shape of these cases was adapted to that of the hold of the ship, some of them being made to fit close under the platform, by which means the quantity of water stowed was considerably greater than could have been stowed, in the same

space,

space, by means of casks; and thereby the stowage-room on-board ship, was very much increased.

The quantity of water kept in this manner on-board each ship, was about forty tons divided into sixteen tanks; and there was likewise, on-board each of the ships, about thirty tons stowed in casks as usual.

As the stowing the water in tanks was considered as an experiment, the water in the casks was used in preference; that in the tanks being reserved for occasions of necessity, excepting that a small quantity of it was used occasionally for the purpose of ascertaining its purity, or when the water in the casks was deemed, when compared with that in tanks, too bad for use.

The water in thirteen of the tanks, on-board one ship, and in all the tanks on-board the other, was always as sweet as when first taken from the source; but in the other three of the tanks, on-board one ship, the water was found to be more or less tainted as in the casks. This difference, however, is easily accounted for, by supposing that the water of these tanks was contaminated before it was put into them; for in fact the whole of the water was brought on-board in casks, for the purpose of filling the tanks, and no particular care was taken, to taste the water at the time of taking it on board.

After the water kept in this manner had remained on-board a length of time which was deemed sufficient for experiment, it was used out, and the tanks were replenished as occasion required: but in some of the tanks, on-board one ship at least, the original water had remained

three

three years and a half, as appears by the certificates herewith inclosed. About twenty-five gallons of the water, which had remained this length of time in the ship, are sent to the Society, in two vessels made of the same sort of tinned copper with which the tanks were lined.

A certificate from Captain William Bolton, commander of the said vessel, dated Sheerness, 28th of June, 1800, accompanied this letter, stating that the water delivered to the Society was taken from a tank holding about seven hundred gallons, and which his predecessor, Captain Portlock, had informed him had been poured into the tank in December 1796, except about thirty gallons added in 1798, and had remained good during the whole time.

The signatures to the above accounts were certified on the 28th of June, 1800, by the Rev. C. Thee, Minister of Sheerness.

In a letter, dated January 27, General Bentham also states, that the water which had been preserved sweet on-board his Majesty's sloops Arrow and Dart, and of which he had sent specimens to the Society, was taken from the well at the king's brewhouse, at Weevil, from whence ships of war, lying at or near Portsmouth, are usually supplied with water for their sea-store, as well as for present use.

XXXIX.

XXXIX. *Description of a new Escapement for Watches.* *By Mr.* John de Lafons.

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

Thirty Guineas were voted to Mr. De Lafons *for this Invention.*

HAVING considered the perfection of chronometers to consist more in giving an equal impulse to the balance than to any other general cause, I present to the Society, the model of a new escapement, which has not only the property of correcting the errors of the main-spring, train of wheels, &c. and giving an equal power to the balance, but likewise the wheels are locked, without spring-work, perfectly safe from getting out of order, and are unlocked with less power than in any escapement I know, as the wheels do not bear against the locking with more than a tenth part of the whole pressure from the main-spring; a circumstance I believe to be perfectly new.

Although the giving an equal impulse to the balance has been already most ingeniously done by Mr. Mudge and Mr. Haley, (from whose great merit I would not wish to detract,) yet the extreme difficulty and expence attending the first, and the very compound locking of the second, render them far from compleating the desired perfection. But I presume I have simplified the above ideas.

The perfections and advantages arising from my improvements on the remontoire detached escapement for chronometers, which gives a perfectly equal impulse to the balance, and not only entirely removes whatever irregularities arise from the different states of fluidity in the oil, from the train of wheels, or from the main-spring, but does it in a simpler way than any with which I am acquainted. I trust it will not be thought improper in me to answer some objections made at the examination before the Committee, as I am fully persuaded the more mathematically and critically the improvements are investigated, the more perfect they will prove to be.

It was first observed, that my method did not so completely detach the train of wheels from the balance as another escapement then referred to. I beg leave to remark, that the train of wheels in mine is prevented from pressing against the locking, by the whole power of the remontoire-spring; so that the balance has only to remove the small remaining pressure, which does away that objection, and also that of the disadvantage of detents, as this locking may be compared to a light balance turning on fine pivots, without a pendulum-spring; and has not only the advantage of banking safe at two turns of the balance, and of being firmer, and less liable to be out of repair than any locking where spring-work is used, but likewise of unlocking with much less power.—It was then observed, it required more power to make it go than usual. Permit me to say, it requires no more power than any other remontoire escapement, as the power is applied in the most mechanical manner possible.—And, lastly, it was said, that it set or required the balance to vibrate an

unusually

unusually large arch before the piece would go. This depends on the accuracy of the execution, the proportionate diameter and weight of the balance, the strength of the remontoire-spring, and the length of the pallets. If these circumstances are well attended to, it will set but little more than the most generally detached escapements.

I proceed to describe mine as follows:

A. (Plate XII.) The scape-wheel.

B. The lever pallet, on an arbor with fine pivots, having at the lower end

C. The remontoire or spiral spring fixed with a collar and stud, as pendulum-springs are.

D. The pallet of the verge, having a roller turning in small pivots for the lever pallet to act against.

E. Pallets to discharge the locking, with a roller between, as in Fig. 4.

F. The arm of the locking pallets continued at the other end to make it poise, having studs and screws to adjust and bank the quantity of motion.

a and *b*. The locking pallets, being portions of circles, fastened on an arbor turning on fine pivots.

G. The triple fork, at the end of the arm of the locking pallets.

The centre of the lever-pallet in the draft, is in a right line between the centre of the scape-wheel and the centre of the verge, though in the model it is not: but may be made so or not, as best suits the calliper, &c.

The scape-wheel A, with the tooth 1, is acting on the lever-pallet B, and has wound up the spring C; the verge-pallet D (turning the way represented by the arrow) the moment it comes within the reach of the lever-pallet, the dischar-

ging-pallet E, taking hold of one prong of the fork, removes the arm F, and relieves the tooth 3 from the convex part of the lock *a*. The wheel goes forward a little, juſt ſufficient to permit the lever-pallet to paſs, while the other end gives the impulſe to the balance: the tooth 4 of the wheel is then locked on the concave ſide of the lock *b*, and the lever-pallet is ſtopped againſt the tooth 5, as in Fig. 3. So far the operation of giving the impulſe, in order again to wind the remontoire-ſpring (the other pallet at E, in the return, removing the arm F the contrary direction,) relieves the tooth 3 from the lock *b*. The wheel again goes forward, almoſt the whole ſpace, from tooth to tooth, winds the ſpiral-ſpring again, and comes into the ſituation of Fig. 1, and thus the whole performance is completed. The end of the lower pallet B reſting on the point of the tooth 1, prevents the wheel exerting its full force on the lock *a*, as in Fig. 1. The ſame effect is produced by the pallet laying on the tooth 5, by preventing the wheel from preſſing on *b*; and thus the locking becomes the tighteſt poſſible. This eſcapement may be much ſimplified by putting a ſpring with a pallet made in it, as in Fig. 5, inſtead of the lever-pallet, and ſpiral-ſpring. The operation will be in other reſpects exactly the ſame, avoiding the friction of the pivots of the lever-pallet. This method I prefer for a piece to be in a ſtate of reſt, as a clock; but the diſadvantage, from the weight of the ſpring in different poſitions, is obvious.

The locking may be on any two teeth of the wheel, as may be found moſt convenient.

Fig 5.

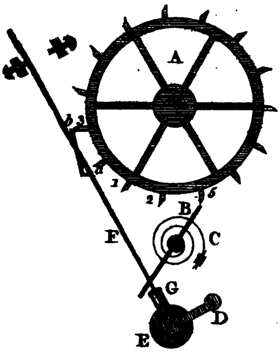


Fig 3.

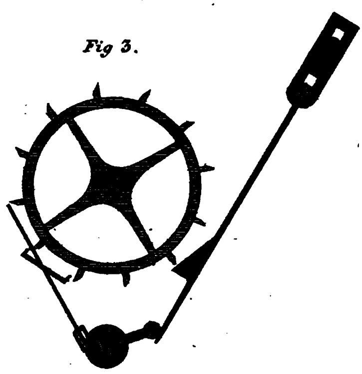


Fig 1.

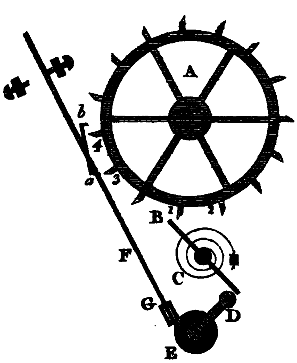


Fig 2

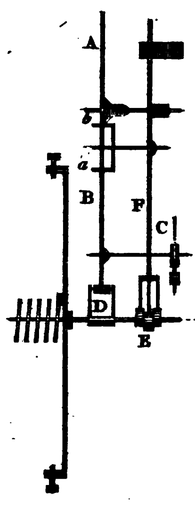
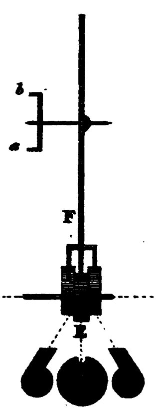


Fig 4.



XL. *On a new fulminating Mercury.* *By* Edward Howard, *Esq. F. R. S.*

(Continued from Page 175.)

SECTION XIV.

THESE effects all tend to establish the existence of the nitrous etherized gas, as a constituent part of the powder; and likewise corroborate the explanation I have ventured to give of the action of the sulphuric acid. Moreover, a measured ounce and a half of nitrous acid, holding 100 grains of mercury in solution and 2 measured ounces of alcohol, yield 90 cubical inches only of gas: whereas, without the intervention of mercury, they yield 210 inches. Upon the whole, I trust it will be thought reasonable to conclude, that the mercurial powder is composed of the nitrous etherized gas, and of oxalate of mercury with excess of oxygen.

1st. Because the nitric acid converts the mercurial powder entirely into nitrous gas, carbonic acid gas, acetous acid, and nitrate of mercury.

2dly. Because the dilute sulphuric acid resolves it into an uninflammable oxalate of mercury, and separates from it a gas resembling that into which the same acid resolves the nitrous etherized gas.

3dly. Because an uninflammable oxalate is likewise left, after the muriatic acid has converted a part of it into sublimate.

4thly. Because it cannot be formed by boiling nitrate of mercury in dulcified spirit of nitre; although

although a very inflammable oxalate is by this means produced.

5thly. Becaufe the difference of the product of gas, from the fame meafures of alcohol and nitrous acid, with and without mercury in folution, is not trifling; and,

6thly. Becaufe nitrogen gas was generated during its combuftion in the glafs globe.

Should my conclufions be thought warranted by the reafons I have adduced, the theory of the combuftion of the mercurial powder will be obvious to every chemift. The hydrogen of the oxalic acid, and of the etherized gas, is firft united to the oxygen of the oxalate, forming water *; the carbon is faturated with oxygen, forming carbonic acid gas; and a part, if not the whole of the nitrogen of the etherized gas, is feparated in the ftate of nitrogen gas; both which laft gafes, it may be recollected, were after the explofion prefent in the glafs globe. The mercury is revived, and, I prefume, thrown into vapour; as may well be imagined, from the immenfe quantity of caloric extricated, by adding concentrate fulphuric acid to the mercurial powder.

I will not venture to ftate, with accuracy, in what proportions its conftituent principles are combined. The affinities I have brought into play are complicated, and the conftitution of the fubftances I have to deal with not fully known. But, to make round numbers, I will refume the ftatement, that 100 grains of the mercurial pow-

* Drops of water were obferved on the internal furface of the globe, the day after feveral explofions had been produced in its centre.

der

der loſt 16 grains of its original weight, by treatment with dilute ſulphuric acid : 84 grains of the mercurial oxalate, mixed with a few minute globules of quickſilver, remained undiſſolved in the acid. The ſulphuric liquor was ſaturated with carbonic of potaſh, and yielded 3,4 grains of carbonate of mercury. If 1,4 grain ſhould be thought a proper allowance for the weight of carbonic acid in the 3,4 grains, I will make that deduction, and add the remaining 2 grains to the 84 grains of mercurial oxalate and quickſilver ; I ſhall then have,

Of oxalate and mercury, - - -	86 grains.
And a deficit, to be aſcribed to the nitrous etherized gas and exceſs of oxygen, - - - - - - - -	14
	100

It may perhaps be proper to proceed ſtill further, and recur to the 48,5 grains, ſeparated by nitrate of lime from the 84 grains of mercurial oxalate and globules of quickſilver, in the 11th ſection. Theſe 48,5 grains were proved to be chiefly oxalate of lime ; but they likewiſe contained a minute inſeparable quantity of mercury, almoſt in the ſtate of quickſilver, formerly part of the 84 grains from which they were ſeparated. Had the 48,5 grains been pure calcareous oxalate, the quantity of pure oxalic acid in them would, according to Bergmann *, be 23,28 grains. Hence, by omitting the 2 grains of mercury in the 3,4 grains of carbonate, 100 grains of the mercurial

* Bergmann de Acido Sacchari. Opuſcula. Tom. I. §. 6. p. 248. Leipzig, 1788.

powder

powder might have been ſaid to contain of pure oxalic acid 23,28 grains; of mercury 62,72 grains; and of nitrous etherized gas and exceſs of oxygen 14 grains. But, as the 48,5 grains were not pure oxalate, inaſmuch as they contained the mercury they received from the 84 grains, from which they were generated by the nitrate of lime, ſome allowance muſt be made for the mercury ſucceſſively intermixed with the 84 grains and the 48,5 grains. In order to make correſponding numbers, and allow for unavoidable errors, I ſhall eſtimate the quantity of that mercury to have amounted to 2 grains, which I muſt of courſe deduct from the 23,28 grains of oxalic acid. I ſhall then have the following ſtatement:

That 100 grains of fulminating mercury ought to contain of pure, oxalic acid, - - - - - - -		21,28 grains.
Of mercury formerly united to the oxalic acid, - - -	60,72	
Of mercury diſſolved in the ſulphuric liquor, - - -	2	
And of mercury left in the ſulphuric liquor after the ſeparation of the gaſes, - -	2	
Total of mercury, - -		64,72
Of nitrous etherized gas, and exceſs of oxygen, - - - - - - -		14
		100

Since 100 grains of the powder ſeem to contain 64,72 grains of mercury, it will be imme-

diately

diately enquired, what becomes of 100 grains of quickſilver, when treated as directed, in the deſcription of the proceſs for preparing the fulminating mercury.

It has been ſtated (in Section IX.) that 100 grains of quickſilver produce, under different circumſtances, from 120 to 132 grains of mercurial powder; and, if 100 grains of this powder contain 64,72 grains, 120 grains, or 132 grains, muſt, by parity of reaſoning, contain 78,06 grains, or 85,47 grains; therefore 13,34 grains, or 20,75 grains, more of the 100 grains are immediately accounted for; becauſe 64,72 grains + 13,34 grains = 78,06, and 64,72 grains + 20,75 grains = 85,47 grains. The remaining deficiency of 21,94 grains, or 14,53 grains, which, with the 78,06 grains, or 85,47 grains, would complete the original 100 of quickſilver, remains partly in the liquor from which the powder is ſeparated, and is partly volatilized in the white dence fumes, which in the beginning of this paper I compared to the liquor fumans of Libavius. The mercury cannot, in either inſtance, be obtained in a form immediately indicative of its quantity; and a ſeries of experiments, to aſcertain the quantities in which many different ſubſtances can combine with mercury, is not my preſent object. After obſerving, that the mercury left in the reſiduary liquor can be precipitated in a very ſubtle dark powder, by carbonate of potaſh, ſhall content myſelf with examining the nature of the white fumes.

SECTION XV.

It is clear, that these white fumes contain mercury: they may be wholly condensed in a range of Woulfe's apparatus, charged with a solution of muriate of ammoniac. When the operation is over, a white powder is seen floating with ether on the saline liquor, which, if the bottles are agitated, is entirely dissolved. After the mixture has been boiled, or for some time exposed to the atmosphere, it yields to caustic ammoniac a precipitate, in all respects similar to that which is separated by caustic ammoniac from corrosive sublimate.

I would infer from these facts, that the white dence fumes consist of mercury, or perhaps oxyd of mercury, united to the nitrous etherized gas; and that, when the muriate of ammoniac containing them is exposed to the atmosphere, or is boiled, the gas separates from the mercury; and the excess of nitrous acid, which always comes over with nitrous ether, decomposes the ammoniacal muriate of sublimate, and forms corrosive mercurial muriate or sublimate. This theory is corroborated by comparing the quantity of gas estimated to be contained in the fulminating mercury with the quantities of gas yielded from alcohol and nitrous acid, with and without mercury in solution; not to mention that more ether, as well as more gas, is produced without the intervention of mercury; and that, according to the Dutch chemists, the product of ether is always in the inverse ratio to the product of nitrous etherized gas. Should a farther proof be thought necessary of the existence of the nitrous etherized gas in the fulminating mercury, as well as in the white dense fumes, it

it may be added, that, if a mixture of alcohol and nitrous acid holding mercury in solution be so dilute, and exposed to a temperature so low, that neither ether nor nitrous etherized gas are produced, the fulminating mercury, or the white fumes, will never be generated; for, under such circumstances, the mercury is precipitated chiefly in the state of an inflammable oxalate. Farther, when we consider the different substances formed by an union of nitrous acid and alcohol, we are so far acquainted with all, except the ether and the nitrous etherized gas, as to create a presumption, that no others are capable of volatilizing mercury, at the very low temperature in which the white fumes exist, since, during some minutes, they are permanent over water of 40° Fahrenheit.

SECTION XVI.

Hitherto, as much only has been said of the gas which is separated from the mercurial powder by dilute sulphuric acid, as was necessary to identify it with that into which the same acid can resolve the nitrous etherized gas: I have farther to speak of its peculiarity *.

The characteristic properties of the inflammable gas seem to me to be the following:

1st. It does not diminish in volume, either with oxygen or nitrous gas.

2dly. It will not explode with oxygen by the electric shock, in a close vessel.

* It must be first noticed, that it is never pure when obtained from the nitrous etherized gas; nor am I aware how it is to be purified, unless the nitrous gas could be taken from it, without being converted into nitrous acid; for, by that acid, it would probably be itself converted into nitrous gas.

3dly. It burns like hydrocarbonate, but with a bluish-green flame. And,

4thly. It is permanent over water. (Section XII.)

It is of course either not formed, or is convertible into nitrous gas by the concentrate nitric and muriatic acids; because by those acids, no inflammable gas was extricated from the powder.

Should this inflammable gas prove not to be hydrocarbonate, I shall be disposed to conclude, that it has nitrogen for its basis; indeed, I am at this moment inclined to that opinion, because I find that Dr. Priestley, during his experiments on his dephlogistated nitrous air, once produced a gas which seems to have resembled this inflammable gas, both in the mode of burning and in the colour of the flame.

After the termination of the common solution of iron in spirit of nitre, he used heat, and got, says he, * "such a kind of air as I had brought "nitrous air to be, by exposing it to iron, or "liver of sulphur; for, on the first trial, a can-"dle burned in it with a much enlarged flame. "At another time, the application of a candle "to air produced in this manner was attended "with a real, though not a loud explosion; and, "immediately after this, a greenish-coloured "flame descended from the top to the bottom of "the vessel in which the air was contained. In "the next produce of air, from the same process, "the flame descended blue, and very rapid, "from the top to the bottom of the vessel."

These greenish and blue-coloured flames, descending from the top to the bottom of the vessel, are precisely descriptive of the inflammable gas

* Priestley on Air, Vol. II. p. 58. Birmingham, 1790.

separated

separated from the powder. If it can be produced with certainty by the repetition of Dr. Priestley's experiments; or should it by any means be got pure from the nitrous etherized gas, my curiosity will excite me to make it the object of future research; otherwise, I must confess, I shall feel more disposed to prosecute other chemical subjects: for having reason to think that the density of the acid made a variation in the product of this gas, and having never found that any acid, however dense, produced an immediate explosion, I once poured 6 drams of concentrate acid upon 50 grains of the powder. An explosion, nearly at the instant of contact, was effected: I was wounded severely, and most of my apparatus destroyed. A quantity moreover of the gas I had previously prepared, was lost by the inadvertency of a person who went into my laboratory, whilst I was confined by the consequences of this discouraging accident. But, should any one be desirous of giving the gas a further examination, I again repeat, that as far as I am enabled to judge, it may with safety be prepared by pouring 3 drams of sulpuric acid, diluted with the same quantity of water, upon 50 grains of the powder, and then applying the flame of a candle until gas begins to be extricated. The only attempt I have made to decompose it, was by exposing it to copper and ammoniac; which during several weeks did not effect the least alteration.

TO BE CONCLUDED IN OUR NEXT.

XLI.

XLI. *Description of a Stove, on the Principles of those used in Sweden, with Apertures emitting heated air.* By Citizen Guyton.

FROM THE *ANNALES DE CHIMIE.*

ALTHOUGH the true principles of constructing chimneys and stoves, so as to obtain the greatest heat from the smallest quantity of fuel, have, for some time past, been known in France, yet they are far from being so generally practised as public economy seems to require.

It is probably owing to the first attempts to introduce the Swedish stove not having been conducted on the true principles, or executed in just proportions, that they are still so rarely used. That which I have built having appeared to many persons to unite in the highest degree all the advantages that can be desired, and to produce an astonishing effect, considering the size of the apartments and its exposure to the North, they have requested me to give them the plan of it with the exact dimensions and the mode of construction. To comply with these requests, I determined to have an engraving made, and accompany it with such a description, that the same effects, with such materials as are to be had, may every where be produced.

I do not, therefore, pretend to the merit of invention; I have merely made a successful application of well-known principles; nor will it be useless to lay them down in a simple manner, and even to give a short sketch of the former advances of the important art of economically producing warmth, before we proceed to that description.

I. Heat

I. Heat is produced only in proportion to the volume of air consumed by the fuel.

II. The quantity of heat produced is greatest (the quantity and quality * of the fuel being the same), when the combustion is complete.

III. The combustion is the more complete in proportion as the fuliginous part is longer retained in channels, where it may undergo a second combustion.

IV. The only useful heat is that sent out into, and retained in, the space intended to be heated.

V. The temperature of that space will be higher, in proportion as the current, which must be renewed from without to support the combustion, is less enabled to take up in its passage the heat produced.

Hence the following inferences evidently flow:

1. The fire-place ought to be insulated from all bodies that are rapid conductors of heat. All the heat that goes out of the apartment is absolutely lost, unless intentionally directed into another apartment.

2. Heat being produced only by combustion, and combustion being sustained only by a current of air, this current should be brought in by channels, where the needful rapidity may be preserved, without being too distant from the space to be warmed; so that the heat it there deposits may be gradually accumulated in the whole of the insulated furnace, in order afterwards to flow out of

* This expression regards not merely the species of wood; for the soil that produced it, and the season when cut, cause great variation; and especially a green or moist wood is well known to produce less sensible heat; part of the latter being absorbed to convert the water into vapour, and not again discharged till it is condensed at a distance from the apartment to be warmed.

of it slowly, according to the laws of the equilibrium of that fluid.

3. The wood being so far consumed as to give no more smoke, it is advantageous to close the mouth of these channels, in order to retain there the heat that would otherwise be carried off through the upper flue, by the continuance of a current of fresh air, necessarily of a lower temperature.

4. Lastly, it follows, from the fifth maxim, that, all other things being equal, a higher temperature will be obtained, and supported during a much longer time, by forming, in the internal parts of the stove, or under the hearth of a chimney, and in their vicinity, tubes, in which the air that comes from without may be warmed, before it enters the apartment to serve the purpose of combustion or re-place that which has been consumed. These have been called *bouches de chaleur (mouths*; or apertures, *of heat*), because, instead of contemplating their principal use and intention, it is commonly imagined, that they are only made in order to give, by their issues, a more rapid current to the heat produced. Nor is this idea absolutely devoid of foundation, since they cause, if we may use the expression, a more real enjoyment in some respects, and the air that issues from them has only changed its temperature by carrying off a portion of the heat that would have remained in the interior. Those, however, who would prescribe them as opposing the most important object, which is the retaining it as long as possible, do not consider that they may be closed, and all communication with the external air cut off by a simple slide, and therefore that it is easy to derive from them every possible advantage,

vantage, without any inconvenience. And we may add, that, in small apartments, or such as are accurately closed, they are often indispensably requisite, if we would avoid being exposed to currents of cold air *.

Such were the considerations that induced me to form similar heating apertures in the stove I constructed in the Swedish method, though not indicated in any of their plans. But, before I describe the forms and proportions I adopted, and the truly astonishing effects produced, it will not be useless to take a view of the successive contrivances and practices employed to reconcile with economy the necessity of raising the temperature in the various habitations of mankind.

Sketch of the Progress of the Art of warming Apartments economically.

Few traces remain of the manner in which the antients warmed their habitations. It is imagined they lighted a large fire in the middle of a room of which the roof was open, and that the other apartments were warmed by portable braziers. In Seneca's time they began to construct tubes in the walls to convey the heat into the upper apartments, the fire-places being still placed below. It appears, however, that this was the origin of flues for smoke, and even of stoves; the situation and proportions of which successively underwent an infinity of changes, according to the localities, the wants of the inhabitants, or the style of the decorations.

* Dr. Franklin very justly quotes, on this subject, a Chinese proverb to this effect: Shun a current of air from a narrow passage, as you would shun the point of an arrow.

decorations. I shall not speak of the custom of heating apartments by fires placed under arches or vaults, as it may easily be imagined, that this was confined to palaces, and other edifices where magnificence was augmented by prodigality; and the vestiges of it that have been discovered among ancient ruins sufficiently point out this as their destination. In digging, some years ago, for foundations in the city of Autun, one of these ovens was discovered under a mosaic pavement, with chimneys at each extremity.

Francis Keslar of Frankfort, whose work entitled Epargne-bois, &c. (the Wood-saver, &c.) appeared in French in 1619, was the first writer that deserves to be quoted as having proposed any useful ideas on this subject. In his stoves he formed eight chambers, one above another, through which the smoke was to pass before it entered the chimney. He also brought air directly from without into the ash-pan to feed the fire, and there was another aperture to draw air from the apartment for the same purpose.

TO BE CONCLUDED IN OUR NEXT.

XLII. *Experiments on various kinds of Potash, with easy Methods of ascertaining the Quantities of Alkali and of foreign Salts they contain. By Citizen* VAUQUELIN.

FROM THE *ANNALES DE CHIMIE.*

MUCH attention has already been bestowed on the various kinds of potash, especially by Mr. Kirwan,

Kirwan, who has treated of them with great minuteness in a memoir, a translation of which has appeared in the eighteenth volume of the "Annales de Chimie." But he only considers them with regard to their use in bleaching, and had merely in view to ascertain the respective quantities of alkaline parts contained in each.

For this purpose he dissolves in water equal quantities of these alkalies, to separate the earthy substances which are indissoluble, and adds a solution of alum till no farther precipitate is formed and the liquor shows a slight excess of acid. He then washes the sediment, and exposes it to a red heat, to expel the water and carbonic acid combined with it.

This is certainly a good method, when the only object is to ascertain the quantities of alkali, whether free or combined with carbonic acid. But it must be confessed, that the process is tedious, difficult, and requires a collection of apparatus of which dealers and consumers are rarely possessed. Besides, there are some uses in which the neutral salts formed with this alkali, and contained in it, must be considered as bearing a part; such are the manufactures of saltpetre and of glass, where these salts produce effects proportioned to the quantities of alkali they contain. The process I would propose for discovering the real quantity of alkali contained in potash of commerce appears to me more simple, more accurate, and attainable by a greater number of individuals; though a preliminary experiment indeed is necessary, which requires some care. It is as follows:

Take a quantity of potash purified with alcohol and very dry, and saturate it accurately with

nitric acid, the density of which has been ascertained either by the eudiometer or the balance. This acid is afterwards to serve as a standard to try the various potashes of commerce, the quantity of alkali in which is to be discovered. This datum being established, dissolve in a sufficient quantity of water any determined quantity of the potash to be assayed; and pour into the solution the standard nitric acid till the last drops no longer cause any perceptible effervescence. Then heat the liquor for a few moments, without suffering it to boil, in order to expel the carbonic acid that remains combined with it, and mix a few drops of the liquor with a little of the tincture of tournesol, to see if there is not an excess of acid; also with the blue colour of violets; and if neither of these cause a change, it is a certain proof that the saturation is exact. If otherwise, add more acid to the liquor, and *vice versâ*.

To know the precise quantities of alkali contained in the potash, it will then be sufficient to compare the quantity of acid absorbed in this operation with that which was necessary for the saturation of the pure potash used as a standard.

It is essential to the accuracy of this trial, that the acid be not too concentrated, because in that case it would be more difficult to arrive at perfect saturation. That which I employed was equal to 20 degrees of Beaumé's eudiometer, and its density was to that of water as 1165 to 1000.

It is apparent, that by this method, and with a little care, the alkali contained, whether in a free state or combined with the carbonic acid, may be pretty accurately ascertained. I believe the error when performed on a few ounces will scarcely exceed two or three centiemes; a quantity

tity of very little importance in potash of commerce.

One fact I observed in this operation, which appeared interesting; that the kinds of potash, which afforded the least alkali, communicated to the water in which I dissolved them more density than those which contained a larger quantity. This observation was fully confirmed by the pure and dry potash, which I employed for my comparison, as will be seen by the following table of the densities given to water by various kinds of potash. And hence it follows, that the salts mixed with potash communicate to the water, when dissolved, more weight than the alkali itself.

Another circumstance is no less curious; namely, that solutions of the different kinds of potash become lighter when saturated with nitric acid, the weight of which, however, is greater than theirs. This explains the reason why the alkaline carbonates absorb heat, or produce cold, by uniting with the nitric acid, and why saltpetre produces so much heat when it burns any combustible body; namely, that in combining with potash, and probably with other alkalies, it retains a great deal of heat itself.

The following table exhibits a comparative view of the quantities of alkali employed, of the water in which they were dissolved, of the nitric acid necessary to saturate them, the density of these solutions before and after their combination with the nitric acid, and, lastly, the quantities of real alkali they contain.

Quantities

Quantities of						
Alkali.	Water.	Denfity of the Solutions.	Acid required to faturate.	Denfity of the Liquor when faturated.	Real Quantity of Alkali	Infoluble fubftance.
Pure Alkali 1152	6912	1·1190	4608		1152	0
Dantzic Potafh 1152	6912	1·0985	2412	1·0550	603 or 0·524	79
Ruffian Potafh 1152	6912	1·1285	3088	1·0920	772 or 0·670	56
From the Vofges 1152	6912	1·1050	1776	1·0920	444 or 0·385	21 a 34
Hard American Potafh 1152	6912	1·1253	3426	1·0753	857 or 0·743	2
Treves Potafh 1152	6912	1·1173	2880	1·0846	720 or 0·626	24
Pearlafh 1152	6912	1·1130	3016	1·0940	754 or 0·656	6

By here considering only the real quantities of alkali contained in each kind of potash we may easily estimate their respective value, taking as their measure the proportions above established.

It may be objected indeed, that the absolute quantities of alkali in each potash will not always be the same, and consequently their proportions will frequently vary. Agreed: for many causes may easily be imagined that will produce this variation; and therefore I do not pretend to make the results of my experiments correspond with all times and circumstances. I am of opinion, however, that the differences which the various kinds of potash exhibit will rarely be very important in commerce and manufactures; unless they are fraudulently adulterated.

But, it must be remembered, that the value of these potashes ought not always to be strictly appreciated by the real quantity of alkali: the foreign substances contained being inconvenient for some purposes necessarily require a diminution of price, while for others they have a certain value. Sulphate of potash, for instance, is useful in making saltpetre, but destitute of utility in bleaching. And therefore it is rather by the wants of the consumer than the purity of the article, that its value should be appreciated.

Hence then it is desirable to ascertain, by a simple and accurate process, the quantities of this salt contained in the various kinds of potash, which are the subjects of these assays; that every one may choose, according to his wants, that which, in proportion to its market-price, offers him the greatest advantages.

For this purpose I mixed nitrate of barytes with solutions of 1152 parts of potash, of which

I had saturated the alkali with the nitric acid, and I obtained precipitates of sulphate of barytes, the weights of which gave me the sums of sulphuric acid and those of sulphate of potash, the proportions of the elements of the two salts being known pretty accurately.

From these proportions it follows, that the quantities of sulphate of barytes very nearly correspond with the half of their weight of sulphate of potash, and with the 28 centiemes of potash contained in the latter.

The following table shews the comparative quantities of sulphate of potash and of alkali furnished by various kinds of potash from a quantity of 1152 parts.

	Sulphate of Potash.	Pure Potash corresponding.	
1. Dantzic potash – –	154	86 or	0·074
2. Russian potash – –	065	37	0·032
3. Potash from the Vosges	148	83	0·072
4. Hard American potash	154	87	0·075
5. Treves potash – –	165	93	0·081
6. American pearlash –	80	45	0·039

It was also an object of my attention to determine the quantities of muriatic salts, and particularly of muriate of potash, from which scarcely any kind of potash is free. For this purpose I mixed nitrate of silver with the solutions of potash, having neutralized the alkali with nitric acid, and detached the sulphuric acid by means of nitrate of barytes. The weights of the precipitates gave me those of the muriatic acid, and consequently of the muriate of potash, since the proportions of these two salts are known. These quantities in 1152 parts of potash are as follow.

1. Dantzic

1. Dantzic potash	– –	14	or	0·012
2. Russian potash	– –	5		0·004
3. Potash from the Vosges		510		0·443
4. Hard American potash		20		0·017
5. Treves potash –	– –	44		0·038
6. American pearlash	–	4		0·003

Although muriate of potash forms saltpetre with the calcareous nitrate contained in the lixivia of the earths, it is considered as of no value, because it produces an equal quantity of mother-liquor, which interferes with the crystallization, and of which the manufacturers always endeavour to rid themselves; so that being found in potash it rather diminishes than augments its value. Though this salt does not enter into the composition of glass, it seems to accelerate the fusion of the materials, mixing them more intimately by means of the motion it acquires in consequence of the heat, by which it is converted into vapour. It ought not, however, to add to the price of the real potash for the use of glass-houses, because, if on the one hand it hastens the fusion of the glass, on the other it renders the refining it more difficult. As to bleaching, it does not appear to be very efficacious, but is not prejudicial.

For those purposes, to which the alkaline parts alone are useful, the value of the various kinds of potash are in the same proportion as the quantities of acid necessary for their saturation; since, in fact, there is nothing but the alkali, pure and combined with the carbonic acid, that can neutralize the nitric acid. Taking therefore for our ground-work one of these quantities, or the alkali it represents, (which comes to the same,) and comparing it with the market-price of the potash that furnished it, we shall have a compa-

 rative

rative table of the true values of these articles, as to the quantity of alkali they contain. But, for the advantage of the consumer, we ought to take for our standard that kind of potash which, with regard to its alkali, is at the lowest price. We ought, therefore, for this purpose, to know the price of each, and the quantity of alkali it contains. At the present time these prices being as follow,

			Potash.
Hard American potash	70 livres,	and containing	0·748
Pearlash	60		0·656
Dantzic	57·10		0·524
Treves	55		0·625
Russian	55		0·670
Vosges	35		0·385

it is apparent that Russian potash should be taken as our standard, because its market-price compared with the others is below the quantities of real alkali which they contain. Hence it follows:

1. Russian potash	55	livres per quintal.
2. American	61	
3. Pearlash	54.3	
4. Treves	51.6	
5. Dantzic	43	
6. Vosges	31.12	

Russian potash, therefore, affords the consumer the most advantage, and Dantzic the least; so that the market-price of these articles appears to be formed on arbitrary notions, or in other words on ancient prejudices. It is true that their comparative values are somewhat different as to those to whom sulphate of potash is useful, because they do not all contain an equal quantity of that salt: but the difference will at most be three

three or four francs per quintal for thoſe kinds in which it moſt abounds. See the preceding tables.

The following is a table of all the ſubſtances contained in the ſix kinds of potaſh of which we have already ſpoken.

	Real Potaſh.	Sulphate of Potaſh.	Muriate of Potaſh.	Inſoluble reſiduum.	Carbonic Acid and Water.
Ruſſian Potaſh. 1152	772	65	5	56	254 = 1152
American. idem.	857	154	20	2	119 = 1152
Pearlaſh. idem.	754	80	4	6	308 = 1152
Treves Potaſh. idem.	720	165	44	24	199 = 1152
Dantzic Potaſh. idem.	603	152	14	79	304 = 1152
Vorges Potaſh. 148*	444	148	510	34	304 = 1152

* This line of figures is an exact copy of the original, which is evidently wrong.

 The

The manipulations required to ascertain the quantities of real alkali contained in the various kinds of potash are simple and by no means liable to error, if the precautions pointed out above are taken. The only rules to be remembered are: 1st, to employ acid of the same degree of concentration, and to perform the operations at one uniform temperature to ascertain that concentration: 2d, that the acid be not too strong to ascertain with ease the exact point of saturation: 3d, that, whenever the degree of the acid is changed, the preliminary experiment with potash must be repeated, because the real quantities of acid do not exactly keep pace with the densities: 4th, that the accuracy of all the other experiments principally depends on the precision of this first assay: 5th, that the nitric acid must at last be poured in very gently, waiting till the effervescence has intirely ceased, before more be added, for fear of exceeding the true limits: 6th, that it is well to heat the liquor for a few moments before trying it by the coloured papers, that the carbonic acid may cause no mistake.

By these little attentions, which any one may practise without a deep knowledge of chemistry, we may learn, as accurately as possible, the real quantities of alkali contained in the various kinds of potash.

To ascertain the quantities of sulphate of potash, requires a process rather more complex: yet, if we recollect that we have only to pour nitrate of barytes into a solution of potash already saturated with nitric acid until no further precipitate be formed, and that the quantity of sediment deposited being taken away and dried represents 0·50, or

or one half of its weight of sulphate of potash, or 0·28 of pure potash, this process will no longer appear difficult, and every one may easily perform it. If, for instance, we have 100 grains of precipitate, it is evident we should reckon 50 grains of dry sulphate of potash, or 28 grains of dry potash; but, if we obtain any other quantity, the determination of the alkali may not be quite so easy to those who are not familiar with arithmetical calculations; and in this case, which more frequently happens, we must multiply the sum of the precipitate by 28, and divide the product by 100. Suppose, for instance, the weight of the precipitate is 85 grains; multiply by 28, and the product is 2380; which, divided by 100, gives 23·8; which represents the quantity of sulphate of potash.

As to the muriate of potash, the carbonic acid, and other foreign substances, it appears to me useless here to mention the method of ascertaining their quantities, because they cannot be of any use, and because, if we know the quantities of potash and of sulphate of potash, we may consider as foreign all the remaining complement of the crude potash.

It is important, however, in some manufactures, and particularly in those of crystals and of plate-glass, to ascertain whether the potash to be used contains iron; because in these manufactures every colouring substance must be avoided.

This circumstance is easily known by exposing the insoluble residua to the action of the muriatic acid, and pouring into this solution caused thereby prussiate of potash, till no farther precipitate is formed; after which, by taking about a fourth

part

part of this precipitate, or by calcining it by fire, we ſhall have as near as can be the quantity of oxyd of iron contained in the potaſh.

Note. Citizen Riffault, adminiſtrator of the powder and ſaltpetre manufactories, has long been endeavouring to diſcover a ſimple method at once to exhibit, in one ſimple experiment, the quantities of alkali, in an uncombined ſtate, and combined with the ſulphuric acid, contained in the potaſhes of commerce. He thinks he has diſcovered it in the nitrate of ſtrontites, the quantity of which required to ſaturate theſe potaſhes indicates the quantity of alkali they contain. It was on this occaſion that he invited me to make the experiments here related, in order to check his reſults. I muſt declare that they agree with mine in many points, and that in none was there any conſiderable difference.

XLIII. *On a Method of preserving Plants and Seeds during long Voyages.*

By CHARPENTIER DE CAUSSIGNY.

Read at the SOCIÉTÉ ACADÉMIQUE DES SCIENCES.

THE agricultural ſociety of the department of the Seine having requeſted me to give them a particular account of the facts, I had the honour to communicate at their ſitting of the 14 Vendémiare, in the year 10, relative to the method I employed

employed for bringing the Batavian ſugar-cane in good condition from the Iſle of France to Paris, I recalled to their recollection, that in the year 8 they had been pleaſed to ſend to the miniſter of marine, and of the colonies, an extract of a memoir, which I had read at one of their ſittings on the ſugar-cane of Batavia; and that they had requeſted that miniſter to import ſome of them into France, as alſo of thoſe from Otaheite, which were cultivated at Guadaloupe, and which were ſpoken of as an excellent ſpecies.

Of the Batavian cane there are two ſorts; one called the *red*, with reddiſh ſtems and leaves; the other called the *white* or *green*, with yellowiſh ſtems when ripe, and leaves of a green colour, bordering on a yellow.

Having been ſent by Government, in the month of Ventôſe, in the year 8, to the Iſle of France, I went to Breſt, where I viſited the national garden. Here I recognized ſome ſticks of the red cane of Batavia, which had recently arrived from Cayenne, in a caſe filled with earth, in which they had been placed in a ſomewhat inclined poſture. The part above the earth might be about ſix or ſeven inches long, two of which at leaſt were dried at the upper end, the remainder being in a ſtate of verdure, though apparently injured. I induced the director of the garden to tranſplant them into the ground as ſoon as poſſible, having firſt cut off the dried part. I adviſed him to cauſe a deepiſh trench or foſſe to be made for each cane, to put at the bottom of each trench ſome dung in good fermentation, and over that ſome good earth, mixed with mould: I recommended laying the canes horizontally,

zontally, and covering them entirely with earth. It was then the month of Germinal, and the weather mild; yet I advised him to keep layers of straw over the canes every night, and to defend them from the north wind. I am ignorant what success attended this little plantation.

I was much surprised, however, that at Cayenne, where the cultivation of the sugar-cane is well known, this box should have been so ill packed. Had the canes been inclined, so that one of their extremities only should be exposed to the air, doubtless the knots that would then have been buried would have produced new shoots. It would have been more proper to have placed them horizontally, and covered them intirely with earth, taking care only to insert such as had two knots at least: or it would have been better still to have transplanted into it stumps with their roots, after cutting off their stems.

These two methods must succeed in short voyages made during the summer. But in long voyages much is to be apprehended from the cold sometimes experienced, and, above all, from the heavy seas in bad weather.

To obviate these two inconveniences, I pursued another method, which I had formerly practised with success, and which I shall now describe.

As soon as I arrived in the Isle of France, I employed my thoughts on fulfilling the wishes of the agricultural society, then unacquainted with the cane called *guingan*, which forms a variety of the red cane of Batavia, so named on account of its red stripes resembling the East India manufacture called ginghams.

I therefore

I therefore sent to the society, by the corvette the Aurora, which sailed from the Isle of France on the 11th of Brumaire, in the year 9, three weeks after my arrival there, a close box, containing sticks of that kind of cane; but the vessel was taken and carried into an English port.

It was my intention to send home, by some other vessel, some Batavian white canes; but no opportunity offered previous to my leaving the colony.

At that time I caused a box to be well constructed of good wood of the country, and strengthened with two iron clamps at each corner.

I chose a light earth, that appeared to me too dry, and moistened it so as to make it rather humid; after which it was well mixed, to render the moisture as equal as possible. I then distributed some of it on the bottom of the box, and kneaded it with my hands; after which operation it might be fifteen lines thick. On this stratum of earth I laid five sticks of ripe cane, two feet two inches long, the box being an inch or an inch and a half longer at each end, and taking care to leave a space between the canes, as also between them and the box. On these canes, which were placed horizontally, I laid a second stratum of earth, which I likewise kneaded with my hands, then a second row of canes, a third layer of earth, and so on till the box was full, finishing by a layer of earth; after which the lid of the box was nailed down, and secured with iron clamps.

This box, which contained white Batavian sugar-canes well selected and ripe, was packed on

 the

the 3d of Pluviose, in the year 9, and arrived at Paris on the 1st of the following Messidor, or after an interval of five months, less two days. Citizen Thouin, to whom it was addressed in conformity to the orders I received from the minister of marine, found all the canes in good condition. He cut them in two, planted them immediately, and they all put out shoots. As this is the most productive species of cane known in our eastern colonies, thrives in every kind of soil, is of quick growth, and yields better sugar, and in greater abundance than others, the government may next year send shoots of it to our western colonies; and I can assure them it will be a most valuable present, especially as this species of cane requires no artificial watering.

The box being placed at the foot of the mainmast on board the Egyptienne, formerly a thirty-six-gun frigate, the vessel in which I returned to France, and being therefore exposed to the air, the rain, and the sun, as well as to the seas we shipped, and even to the cold, I was apprehensive, that during our passage, which lasted 87 (88) days, with very little rain, the earth near the top of the box might grow dry. I therefore caused holes to be made, with an augur, in the cover, about four or five inches apart, and poured water into them, through a funnel, without opening the box; after which I had them well stopped with strong wooden pegs, to prevent the rain, and more especially the salt-water from entering. The former might have been too profuse, and the latter would probably have destroyed the vital principle of the canes.

I watered

I watered the box only twice during the passage, namely, at the expiration of one and two months from my departure, with about a pint and a half of water each time. As we arrived in Spain before the expiration of the third month, the third watering was subsequent to our arrival in Europe.

Besides the advantages of preserving, for a very long period, the life of vegetables, of protecting them during the passage from the seas that come on board, and even from the cold *, (for had it increased I should have placed the box between decks, in the gun-room, or even in the hold); besides these advantages, I say, this method causes a saving of fresh-water, which is of so much importance during long voyages. For to support so large a quantity of canes, planted in the common manner, a pint and a half of water daily would not have been too much; and twelve or fifteen boxes would have been requisite to contain them.

In the same box I placed two large bulbous-roots of a superb flower, which comes from Africa, and is cultivated in the Isle of France, called *lys à fleurs bleues*, and which is of the liliaceous kind. At Bordeaux I transplanted them into two small pots of earth, where they sprouted out, and I brought them to Paris in good condition. I doubt not they will flower next summer, if proper care be taken of them during winter.

Young trees may be carried across the seas in like manner, but they require some additional

* The attacks of cold, and the consequent change of temperature, must also be more gradual, as the whole mass of mould, and not the extremities of the plants, must be first cooled, before the change can effect the vegetation.

care. It would be proper to take them up together with their roots and the earth about them, and they must be laid down in a box between two strata of earth, rather moist than dry, and well kneaded with the hands. The extremities of the roots, and of the branches that were growing, must be cut off, but not the leaves; after which the box must be closed, and watered from time to time during the passage, if long, by the method above described. In a box, sufficiently capacious in all directions, several rows of trees may be packed, whether of the same or different species. I have often used this method with success, and have even caused suckers of the incense-tree to be thus brought from Bengal to the Isle of France, which have all succeeded without exception, after having lain above three months in a close box. In like manner I have imported tricoloured roses, and many other vegetable productions from Bengal into the above-mentioned island.

There are many berries of the almond kind, such as Eugenia, and those of the family of cinnamon and others, that cannot be conveyed to great distances in a state of germination, because they dry very rapidly. These must be placed, while fresh, in earthen-ware, queens-ware, or glass vessels, with earth somewhat less moist than that in the boxes, and the vessels only closed with cork. In this manner, in the year 1772, I brought home from the Isle of France a pot filled with berries of the Ceylon cinnamon tree, transplanted to the Isle of France, which I carefully packed between two earths, one layer above another, putting above 1,500 berries into a small pot, I had paid them no attention during the

passage;

paſſage; but the veſſel had been cloſed with mortar, which ſhrunk in drying, and ſuffered the external to communicate with the internal air. This pot I preſented to my deceaſed friend M. le Monnier, chief phyſician to the king. All the berries grew without exception, and my friend diſtributed ſome of the plants to the national garden, the little Trianon, and various ingenious perſons both at Paris and in the departments; and he even ſent ſome to our colonies in America.

In my laſt voyage to the Iſle of France I myſelf packed, with the ſame care, in a glaſs veſſel, berries of the litchi, the beſt fruit of China; and on my arrival at Bordeaux, after an interval of five months, I found all the berries had taken root. I preſented them to the national garden of that commune. One of my friends, an inhabitant of the Iſle de la Réunion, alſo packed ſome litchis in two glaſs veſſels with earth in my method; but he had hermetically ſealed the veſſel, and I found all the berries dead in conſequence of want of air.

Many other berries, ſuch as the rima or bread-fruit tree, the jacquier, which is of the ſame genus, the jam-malves, jam-roſards, rouſailles, iron-wood, and bois-de-pommes, which are eugenias, and many others, that I ordered my attendants to pack in pots with earth, all periſhed becauſe the earth they uſed was not ſufficiently moiſt, and had not been ſufficiently kneaded. My other avocations prevented my giving perſonally all the attention they required.

XLIV. *Method of purifying Rape Oil.* By *Citizen* THENARD.

FROM THE *ANNALES DE CHIMIE.*

TO 100 parts of rape oil add 2 of concentrated sulphuric acid; mix, and agitate them together. Upon this the oil presently changes its colour, becomes thick, and assumes a blackish-green appearance; after three quarters of an hour it is full of flakes, at which time cease to agitate, but add near double its weight of water, to carry off the sulphuric acid, which, if suffered to remain too long, would act too strongly upon the oil and carbonate it. It is necessary to beat this mixture during at least half an hour, in order to bring the particles of oil, of acid, and of water, into contact with each other, after which it must be left to settle.

After about a week's rest, the oil swims above the water, and the water above a blackish substance precipitated from the oil by the sulphuric acid; which substance is the colouring matter of the oil, and prevents it from burning well. Thus it appears, that the whole arranges itself into three very distinct strata, the upper being oily, the second aqueous, containing a little sulphuric acid, and the third carbonic. But even after this period of rest, the oil that forms the upper station is far from being clear, and I should imagine it would require twenty days to render it transparent by rest alone; but, by filtering the oil, it immediately becomes perfectly clear and pellucid. For this purpose either pounded charcoal, cotton, or wool, may be employed.

ployed. The two laſt are preferable, the ſame cotton and the ſame wool ſerving a great number of times; but after a certain interval they require to be cleared from the greaſe.

By this proceſs, carefully purſued, an oil is obtained infinitely more free from colour, taſte, and ſmell, than that commonly employed, which burns with the greateſt eaſe, and in all reſpects worthy to be compared with the pureſt oils of commerce: add to which, that the loſs in quantity is very inconſiderable.

If it be deſired to obtain a ſtill whiter oil, it may be ſubjected to a ſecond proceſs; but then one part of concentrated ſulphuric acid will ſuffice for 100 parts of oil. In oil once purified, this acid does not cauſe a blackiſh precipitate, but on the contrary of a greyiſh-white, and in no great quantity. This precipitate ſeparates leſs eaſily from the oil than the preceding.

When the oil has been treated with $\frac{1}{100}$ of ſulphuric acid, if it be left to digeſt during twenty-four hours with a quarter of its weight of lime, or of carbonate of lime or argil, it is rendered almoſt as clear as water.

Neither lime, nor carbonate of lime, but eſpecially the former, could be uſed with advantage, becauſe they would occaſion too great a waſte of oil: but I am of opinion that argil would produce advantageous reſults; for, although it in fact retains a conſiderable quantity of oil, almoſt the whole of it might be extracted by means of a preſs.

XLV.

XLV. *On the Impurity of distilled Water. By Mr.* DELUNEL, *Member of the Lyceum of Arts, of the Free Society of Medicine, and of various other learned Societies.*

HAVING frequently obſerved, that the hyper-oxygenated muriate of mercury was not diſſolved in diſtilled water, I was led to examine the cauſe of this indiſſolubility. I found that it aroſe from the water employed being that of wells (ſpring-water). Conſidering this fact therefore as highly important to be eſtabliſhed, I diluted fifteen pints of water, from the neareſt well to my houſe, (Rue Saint-Honoré, near Saint Roch,) in a new copper alembic, lined with tin, and divided the product into three parts, which were received in glaſs veſſels.

All my experiments were repeated with water from various wells in my neighbourhood, and always with the ſame reſult.

As the three diviſions of the ſame diſtillation did not manifeſt the ſame characters, it will be proper to give a ſeparate account of my examination of each.

The firſt, amounting to nearly a third, was not pure, or at leaſt was not capable of diſſolving the muriate of mercury: a pound of this water neither diſſolved that ſalt nor ſoap. Another portion of this firſt diviſion, being tried with the muriate of mercury, and evaporated to one-third, depoſited mercury under the form of grey oxyde, and the liquor over it was covered with a metallic pellicle, exhibiting priſmatic colours. This obſervation of a metallic pellicle will, under other circum-

circumstances, become valuable; it demonstrates the decomposition of muriate of mercury.

Eight ounces of the same water of the first division, without addition of chemical tests, gave a slight precipitate. Nitrate of silver and nitrate of alumine also manifested the impurity of this water, though less sensibly than muriate of mercury.

Of the second division less impurity was perceptible in equal quantities, muriate of mercury gave no precipitate, but the menstruum was less clear, and soap better dissolved than in the first division.

The third division manifested the greatest purity; for in the same proportions of water and of chemical tests muriate of mercury and soap were always perfectly dissolved, and the solutions remained very pellucid. The residuum amounted to three pints, with a considerable sediment of selenite, or calx of sulphur.

This singularity rendered me desirous of discovering the cause; for which purpose I varied my operations, in order to compare the results.

I distilled the same well-water in a water-bath, dividing the products as before; but notwithstanding their pellucidness, muriate of mercury and soap were not dissolved, and the sediment was much less considerable in the residue than in the former distillation over the naked fire.

As a medium of comparison, I distilled water from the Seine, in a thick cloudy state, that it might be the more loaded with substances analogous to those of well-water.

I took the same precautions of dividing the products, and the solution of muriate of mercury and of soap was complete in all the products of

 distillation

diſtillation over the naked fire; which proves that Seine-water, and thoſe which are analogous to it, are perfectly purified by diſtillation; whereas the water from wells, analogous to thoſe from which the water above mentioned was taken, is not thereby perfectly purified.

To diſcover whether I had been anticipated in my conjecture or explanation of this fact, I conſulted various pharmacopæias, and ſeveral chemiſts, who have treated of diſtilled water.

The codex of Paris recommends rain-water, to be diſtilled in a water-bath, of which only two-thirds are to be drawn over. The pharmacopæias of Wurtemburg and London preſcribe ſpring-water diſtilled over a naked fire, and order the firſt product to be rejected. Beaumé, in his Experimental Chemiſtry, adviſes, for the ſake of greater accuracy, to diſtill rain-water in glaſs veſſels, rejecting the firſt products. Fourcroy, in his Elements of Natural Hiſtory and of Chemiſtry, propoſes an alembic of copper lined with tin, without any farther precautions.

Theſe various opinions relative to the diſtillation of water in order to purify it, not being ſupported by any ſpecific reaſons, prove that no ſerious attention has yet been methodically paid to this operation.

Having eſtabliſhed that well-water gives by diſtillation different reſults, it will be proper to endeavour to account for this fact. Diſtillation affords means to ſeparate volatile ſubſtances from thoſe which are fixed. During that operation then volatility of the fluid takes place only in proportion to its dilatation. This is more or leſs conſiderable in proportion to the quantity of caloric developed and combined with the fluid, which

which becomes the more volatile the more it approaches to the ſtate of gas. I hope, therefore, to prove by the following experiments, that from the mere different degrees or proportions of caloric, rather than from heterogeneous ſubſtances, ariſes the difficulty of diſſolving muriate of mercury in certain portions of well-water, even when diſtilled.

Whoever has performed the operation of diſtilling with reflection, and a habit of examining every thing, knows that on the firſt contact of heat, and when the water of the refrigeratory is at 15 or 20 degrees of Reaumur, diſtillation begins, and that the degree of heat increaſes as well by the continuation of the fire as by the neceſſity of feeding the latter more and more to continue the operation.

To aſcertain the degree of heat, which I ſuſpected to be the cauſe of the change in the nature of this water, I placed a thermometer in the capital or refrigeratory of the alembic, which I filled with cold water previous to the commencement of the diſtillation. I obſerved that the water which had begun to diſtil at 20 degrees, did not become a ſolvent of the mercurial ſalt till it had riſen to 75 degrees; two-thirds of the diſtillation having already paſſed over into the receivers, the remainder of the diſtillation was equally fit for diſſolving it.

I then varied my experiment in order to render it more concluſive. In lieu of 15 pints, as in the firſt operation, I only put half that quantity in the alembic; that the quantity of water being ſmaller might be ſooner heated. The reſult was the ſame; namely, that the firſt portions of the diſtilled water did not begin to diſſolve the mer-

curial salt till at 75 degrees of heat. Farther, I again distilled the water of these two distillations, the first obtained, and which I call impure; it was only at 75 degrees of heat that it became a solvent of muriate of mercury. But although the cause of the phænomenon appeared to me demonstrated, I did not neglect to ascertain whether the presence of some saline substance ought to be taken into the calculation. I therefore submitted a fresh quantity of well-water to distillation, putting into the cucurbit, in which it was to be distilled, carbonate of potash, until it ceased to afford any precipitate. I then distilled it; nor was it till the 75th degree of heat that the water became a solvent; the useless products, like those of the preceding operations, manifested nothing particular, nor afforded any precipitate with carbonate of potash, pure potash, and ammoniac.

The detail of all these experiments shows how necessary it was to give attention to the different degrees of heat that took place in succession during the operation, since to these alone I am indebted, if not for a proof, at least for a very probable conjecture, of the cause of the fact, which is the subject of these remarks.

It may be objected, that in all distillations the water of the refrigeratory is never heated to 75 degrees, because it is renewed from time to time, so as to prevent the refrigerating fluid from ever attaining the heat of the distilled fluid. But I reply that the well-water above mentioned was distilled in the same manner, and that the last third of the product was the only part fit for the solution of muriate of mercury, because the temperature of the water in the cucurbit was then 75 degrees.

A com-

A comparison of the two decompositions of muriate of mercury, by distilled well-water, which I call impure, and by well-water not distilled, will confirm my assertion relative to the change effected in this respect by the greater or smaller quantity of caloric dissolved in the volatilized fluid.

Muriate of mercury dissolved in common distilled water, and afterwards mixed with undistilled well-water, does not very readily disturb its pellucidness; but a metallic pellicle with prismatic colours pretty quickly and pretty abundantly covers the surface. In the other mixture, on the contrary, (namely, well-water distilled and impure,) the same decomposition does not take place; the metallic pellicle does not appear; and the precipitate, which at first gives the water a milky colour, forms very speedily. Since of these two kinds of water neither is favourable to the solution of muriate of mercury, but each decomposes that salt in a manner peculiar to itself, this difference in the decomposition must surely depend on the nature of distilled well-water rendered such by the more or less considerable quantity of caloric absorbed by it; and that which I employed in this last experiment had not the quantity necessary.

This experiment proves that well-water will not dissolve muriate of mercury till it has been distilled at a very elevated temperature; whereas river-water requires a very inferior degree of heat.

It further proves, 1st, that distilled well-water, which does not dissolve muriate of mercury, forms no precipitate with various chemical tests;

2d,

2d, that it is neceffary to re-diftill well-water already diftilled, to give it the degree of heat neceffary to render it fit for the folution of muriate of mercury.

The difference of the decompofition of this falt by well-water not diftilled, and by that which has been diftilled, but which I call impure, appears to me demonftrative in favour of the theory I propofe; namely, that the different quantities of caloric abforbed or diffolved in diftilled well-water are the caufe why the firft portions of the fame diftillation do not diffolve muriate of mercury, which the laft will effect.

I do not, however, lay down this feries of experiments as a model of analyfis, or this affertion as a general principle applicable to the diftillation of all kinds of well-water; fince the diverfity of fprings and other local circumftances would oppofe fo uniform a decifion; but the fact, even were it abfolutely peculiar to myfelf, appeared to me to deferve the attention of chemifts.

River-water, it will be faid, is that which is generally diftilled in preference to fpring-water. Agreed; but the cafes of a hard froft, or occafional diftance from thefe ftreams, would alone induce me to hope, my labour will appear neither trifling nor unimportant.

XLVI.

XLVI. *List of Patents for Inventions, &c.*

(Continued from Page 216.)

Alexander Bryce, of Glasgow, in North Britain, Merchant; for a method of drying all kinds of yarn, whether linen, woollen, cotton, or silk, or composed of all or either of these articles, as also all kinds of cloth or stuffs, commonly called piece goods. Dated January 2, 1802.

Thomas Parkinson, in the Parish of St. George, Bloomsbury, Middlesex, Gentleman; for an apparatus to be applied to engines for conveying fluids therefrom. Dated January 2, 1802.

Abner Cowell Lea, of the parish of Ashton, near Birmingham, Warwickshire, Manufacturer; for a method of manufacturing the furniture for umbrellas and parasols.
Dated January 2, 1802.

Lewis James Armand Estienne, of Paul-street, near Finsbury-square, Middlesex, Gentleman; for an invention, communicated to him by a foreigner, of reducing human excrement into a powder, divested of all nauseous smell, preserving at the same time its fertilizing properties in rendering land infinitely more productive and vegetative than any other manure hitherto discovered.
Dated January 9, 1802.

Robert Brown, of new Radford, Nottinghamshire, Lace-manufacturer; for a method of manufacturing nets of all kinds.
Dated January 16, 1802.

Joseph Lewis, of Brimscomb, Gloucestershire, Dyer; for improvements in the art of dying, by means of a new method of cooling the

the cloth and other piece goods (particularly in dying black); and a new mode of applying the fire for the purpose of heating the boiler or other vessels, and which may be also applied to the heating of other boilers or vessels where heat is required. Dated January 16, 1802.

Joseph Hall, of Pitt-street, in the parish of St. Mary, Newington, Surrey; for a hammer for guns, pistols, and other fire-arms, which contains the prime, and effectually preserves it from damp and rainy weather.
Dated January 16, 1802.

Richard Willcox, of the city of Bristol, Engineer; for improvements on the steam-engine furnace or boiler, and air-pump.
Dated January 23, 1802.

Paul de Philipsthal, of the Lyceum, in the Strand, Gentleman; for an optical apparatus, whereby he is enabled to represent, in a dark space or scene, the human figures, in various characters, proportions, and sizes, and by which means painters and other artists may accurately enlarge or diminish with more certainty and facility than has hitherto been known or done. Dated January 26, 1802.

James Sharples, of the city of Bath, Gentleman; for new-invented mechanical powers applicable to steam-engines; part of which machinery may be applied to other useful purposes. Dated January 28, 1802.

Thomas Charles Baker, of Poplar, in the parish of St. Dunstan, Stepney, Middlesex, Millright, for vanes or sails for windmills.
Dated January 28, 1802.

Printed by Nichols and Son, Red-Lion-Passage, Fleet-Street.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XCV.

Printed by NICHOLS and SON, Red-Lion-Paſſage, Fleet-Street.

XLVII. *Specification of the Patent granted to Mr.* FRANCIS BREWIN, *of Bermondſey, in the County of Surrey, Tanner; for an improved Method of Tanning.* Dated November 18, 1801.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid Francis Brewin, in compliance with the ſaid proviſo expreſſed and contained, do hereby declare, that the nature of my ſaid invention, and the manner in which the ſame is to be performed, are as follows, *viz.* My improved proceſs of tanning conſiſts principally in conſolidating floaters and taps, that is by drawing the oozes for the vats, and handlers from the floaters, and working the oozes through the floaters in every reſpect as though they were a ſet of taps, and uſing them at the ſame time in the nature of floaters, by handling the greeneſt packs in them. Theſe vats I call floating taps. My proceſs I deſcribe more particularly as follows: Twenty or twenty-five vats I conſider as conſtituting one complete tan-yard; and my vats be-

ing nearly of one ſize, I take two or three of the centre vats, which I uſe as ſpenders; four or ſix immediately next to theſe I make my floating taps, each containing an eye and a falſe bottom. The remainder are vats and handlers, in which I uſe all my freſh bark. One floating tap I keep empty, that it may contain the whole of the ooze and bark in a vat or handler, into which floating vat I draw the ooze and bark, from that vat or handler, which I conceive moſt neceſſary to be drawn. I draw off by a pump from this floating tap, now the beſt, my oozes into the vat or handlers from which it laſt came, making up the deficiency from the ſecond floating tap, late the beſt; but working it firſt through the one now made I put the goods down in the drawn oozes, with about three times the quantity of bark that is generally uſed with one pack. I continue to work the whole of the floating taps as though they were one ſet of taps; but firſt I throw up each pack of goods, and after the floating taps are worked through, I ſhift the floating packs as in a ſet of handlers. The bark in the late worſt floating tap, being after the whole has been worked through thrown into the ſpender, cauſes ſuch floating tap to become the empty floating tap, ready to receive the ooze and bark from the vat or handler next to be drawn. Experience perhaps may prove it to be moſt advantageous, particularly where the number of floating taps exceed ſix, to draw the oozes from one of the more backward floating taps inſtead of the beſt; in this caſe thoſe floating taps only that follow the one drawn from muſt be conſidered as floating taps, and the others worked merely as floaters, by ſhifting the packs only. In this caſe, ſome

labour

labour in pumping would be ſaved, and the goods before they go into the freſh bark would be more tanned. The precise number of floating taps in a yard is not very material, but more than ten I conceive will ſeldom be found moſt advantageous, or leſs than four. By diſpoſing of the ſpenders, floating taps, vats, and handlers, as before deſcribed, barrows or long ſhoots will ſeldom if ever be required to convey the bark or ooze from the vats or handlers to the floating taps, or from the floating taps to the ſpenders, as ſuch vats or handlers may be drawn as lie next to the empty floating tap, and ſuch floating tap is ſo diſpoſed as to lie next to the ſpender that has received its bark, as may be ſeen by a plan of two of my yards in the margin. I draw ſo many vats or

V	H	V	H	V
H	Empty. F.T.	S 3	F.T. 1	H
V	F.T. 5	S 2	F.T. 2	V
H	4 F.T.	S 1	F.T. 3	H
V	H	V	H	V

V	H	V	H	V
H	Empty. F.T.	S 2	1 F.T.	H
V	3 F.T.	S 1	2 F.T.	V
H	V	H	V	H

handlers into each floating tap, as that when the goods and oozes are out of them the bark will about one half fill them; but as I generally put as much bark into a vat or handler as will be sufficient for this purpose, I do not often draw more than one vat or handler into one floating tap; one spender will contain two floating taps, from which, if the spenders are just half the number of the floating taps, which I consider as a proper proportion, the whole will both be worked round, or emptied in the same time, of course the floating tap that is to be cast will always continue to be near the spender, that is to receive the bark. Three or four times handling the goods after they have been regularly through the floating taps, besides when drawn for, I find sufficient. I seldom handle the floating taps but when the ooze is drawn, excepting the greenest pack, which I generally handle once in two or three days at least. The size of the vats, handlers, floating taps, and spenders, is not very material, but I consider that the floating taps and spenders should be

at

at leaſt equal in ſize to the handlers and vats. This general rule ſhould be obſerved, not to draw ſo often, or more vats or handlers into a floating tap, as that the floating tap will not contain goods ſufficient to ſpend the bark to your ſatisfaction. By the above proceſs the oozes in the vats and handlers may always be kept about twice as ſtrong as ſuch oozes generally are, as ſo much more bark is uſed at one time with each pack of goods; and as each pack of goods may be drawn for while the ooze continues to be very ſtrong, and of courſe will cauſe the drawn oozes to be very ſtrong alſo, and yet by the proceſs the bark goes through in the floating taps it will be, before thrown away, more completely ſpent than by any other proceſs, from the water being made to go through the bark after it has been uſed in the vats or handlers ſo many more times than is done by the uſual proceſs before it comes to be uſed with the freſh bark, but above all from the green goods, after the oozes are drawn from it, ſpending the bark at the ſame time that it is ſpending, by the water being worked through it. The great advantages derived from this proceſs are, the leather is made of a ſuperior quality, being more ſolid and weighty than other leather, and is manufactured in leſs time, from the oozes in the vats and handlers containing double the quantity of the tanning quality than is contained in common oozes. The leather when curried will be much more water-proof than common leather, as it will take in more oil in the proceſs of currying, provided the oozes in the handlers and vats are not kept ſtronger than oozes in general are. The leather will be much tougher than other leather, as by this proceſs it is not put into old

old acid oozes while green, by which the texture of leather in general is much injured. The leather in manufacturing requires less labour than by any other process, as the labour of drawing oozes from the large quantity of bark used in each ooze is considerably abridged, and there is a saving of bark from its being more completely spent than by any other process, and as the quantity of bark permitted to stand without goods is much less than usual. Elm-bark, or weaker barks than oak, may by this process be used with particular advantages, since the bark is thereby so completely spent, and the labour so much abridged, and inasmuch as it enables the keeping the oozes in the vats and handlers much stronger than by any other process; by which means the leather tanned by elm, or other weak barks, becomes as solid and weighty as common leather tanned by oak-bark. In witness whereof, &c.

XLVIII. *Specification of the Patent granted to Mr.* Robert Dickinson, *of Long Acre, in the County of Middlesex, Gentleman; for certain Improvements in the Construction of, and Additions to, the Saddles, Harness, and other Gear, necessary or useful for the Employ of Horses and other Animals in riding or in carrying Loads, or in drawing Carriages of any Description whatever.*

Dated November 10, 1801.

TO all to whom these presents shall come, &c. Now know ye, that in compliance with the said

said proviso, I the said Robert Dickinson do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed, is hereinafter particularly described and ascertained; that is to say: Whereas in the construction of the saddles, and other gear and appendages hitherto made or manufactured, the several parts have generally possessed no elasticity except that slight degree which might depend upon the nature of the materials themselves, and it consequently follows that saddles and cruppers are either girthed too tight, so as to impede the respiration of the animal, and so as to endanger their breaking, or so loosely as to render the seat of the rider more or less unsafe, and very seldom can be fixed with that exact degree of tension which is best adapted to every useful purpose. And moreover in the adjustment of the crupper and with the breast plate a difficulty of the same nature presents itself, namely, that in the first tension of these, if the same be too loose, the saddle will not be duly confined to its place, or if the same be too tight the animal will be very much incommoded, and in either case, when by sudden jerks or other motions, the breast-plate or crupper, or girth, shall be required to produce their respective effects, the parts will either break, or else the action, particularly of the crupper upon the tail of the animal, will be sudden, unqualified, and pernicious. Now my said improvements in the construction of, and additions to the saddles, harness, and other gear aforesaid, consist in certain springs, or elastic portions interposed between, and in effect constituting parts of the said instruments or parts; that

that is to ſay, more particularly, I improve the conſtruction of ſaddles by affixing one or more ſpiral ſprings, ſimilar to thoſe uſed in the ſmall inſtrument for weighing, commonly called ſpring ſteel-yards, unto thoſe parts of the ſaddle to which the girths, the crupper, and the breaſt-plate are reſpectively to be faſtened. The ſaid ſpiral ſprings are ſo lodged in certain cavities, ſheaths, or receptacles, that a piece of catgut or wire, or chain, or other fit material, paſſing within the cavity of the ſpring, and faſtened to, or bearing againſt one end of the ſaid ſpring, ſhall, when drawn or acted upon, cauſe the turns of the ſpring to approach more nearly together, and conſequently cauſe it to react againſt the ſaid catgut or rod, or chain, or other fit material, and tend to draw the ſame towards the ſaddle itſelf. I fix to the end of the ſaid catgut, rod, chain, or other fit material, ſtraps or buckles, or other faſtenings, for the ready fixing of the girth, breaſt-plate, and crupper, in the uſual manner. And moreover, in ſome caſes where convenience or choice may cauſe the preference, I fix the ſaid ſpiral ſprings, within proper ſheaths or receptacles, of metal, wood, cloth, leather, or other fit material, ſo as to form a ſeparate piece capable of being applied or attached between the ſaddle, and the extremity of the girth, breaſt-plate, or crupper, reſpectively, ſo as to communicate to the ſaid appendages the effect of its own elaſtic extenſibility in the longitudinal direction or otherwiſe. I fix the ſaid ſprings ſo fitted up in the breaſt-plate and crupper in ſuch a manner that the ſame ſhall conſtitute parts of thoſe appendages to the ſaddle, and communi-

cate

cate the same effect as in the other cases just described. And farther, I do hereby declare, that I do not confine myself in the structure and use of the springs or elastic parts of my said invention to any such precision of figure or material as not to allow of considerable variations. The springs may be made to act by drawing the convolutions or turns farther apart instead of compressing the same together, as before described. The wire of which the springs are made may be taken of any fit metal, but steel is the best, and it may be either round, square, or of any other figure, as to its section or base, and the springs may be either straight or curved, according to the numerous well-known forms of springs, and the application thereof; but I consider the spiral or helix, as before described and applied, as the cheapest, most convenient, and as good as any. On some occasions I make use of a simple strap or piece of Indian rubber, or *caoutchouc*, instead of the springs; the use of which springs is supplied by the natural elasticity of the said *caoutchouc*; but I do not consider this last material as deserving any general preference, because its spring or elastic force is greatly weakened by heat, and in cold weather it becomes rigid, and liable to snap. In witness whereof, &c.

XLIX. *Specification of the Patent granted to Mr.* MATTHEW MURRAY, *of Leeds, in the County of York, Engineer; for a Method of constructing the Air Pump, and sundry other Parts belonging to a Steam Engine, by which a considerable saving will be made in the Consumption of Fuel, and an increased Power obtained.*

Dated August 4, 1801.

WITH A PLATE.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with, and agreeable to the true intent and meaning of the said proviso, in the said letters patent contained, I the said Matthew Murray do hereby declare, that the following is a particular description of the nature of my said invention of new methods and improvements on the steam engine, both in respect to principles, and to the way and manner in which they are performed and rendered practically useful; that is to say: First, in respect to principles of the new air pump, I cause the air to be discharged from the air pump without its having to make any effort in opening of valves, or pressing through a body of water, and in causing the water and the air to be discharged separately, and different ways; this is effected by discharging the air alone by one bucket, and the water alone by another, or by an eduction pipe of twenty-eight feet in length, as in the Figs. 1, 2, 3. Secondly. An improved method of packing the cylinder-lid, stuffing boxes for valves, &c. I cause the removeable parts of each to come in immediate contact with one another; this is effected by

by placing the neceſſary packing on the upper ſide of the cylinder-lid (inſtead of being betwixt the cylinder and lid as formerly), which prevents the piſton-rod receiving friction from any oblique preſſure, by the cylinder-lid being ſcrewed down more upon one ſide than the other, which is unavoidably the caſe in all other methods of packing-lids, valves, ſtuffing-boxes, and other ſimilar things, where great accuracy is required, as in Fig. 4. Thirdly. An improvement in the valves and working geer, the principle of which conſiſts in the advantageous form in which they are made, and in the two uppermoſt valves being inverted, and the communication by the valve-rods paſſing through reſervoirs of oil, or liquid matter, which will prevent any air getting into the engine to impair the vacuum; the principle of the cylinder lid is here applied in fixing the ſtuffing-boxes for the valves, and valve-box lids, which is of the utmoſt importance to their operating well, as the oblique preſſure (which cannot be prevented in the old method) throws the valves out of their ſeats, and renders them proportionally imperfect, Fig. 5. Fourthly. A new principle of opening and ſhutting the valves by a circular motion (inſtead of the plug and hand-geer now in uſe,) which prevents the engine making a falſe ſtroke, or turning the wrong way round, by which means a ſteam engine is rendered as ſteady in its motion as a water-wheel, as in Figs. 6, 7, 8, 9. Fifthly. A new method of connecting the piſton-rod to the parallel-motion, as deſcribed in Fig. 10. Sixthly. An improved method of conſtructing fire-places for conſuming the ſmoke ariſing from ſteam engines, and other fires, Fig. 11. Now I do declare, that the ſix above men-

tioned principles comprehend the real object of my inventions. And, in order for the better comprehension and understanding how the aforesaid may be reduced to practical use, I do hereby further declare, that although I vary my mode of construction, as a difference of circumstances may require, to produce the same effect, and obtain the main purposes intended; yet I principally adhere to the methods herein described, as being fully answerable to what is required, and best calculated to be understood from the drawings and descriptions thereof. And the same is described fully in the drawing or plan added hereto, and contained in the skin of parchment hereunto annexed. (See Plate XIII,) Figs. 1, 2, and 3, are plans exhibiting the principle of the air pump. A, the condenser; B, the air pump; C, the air piston; D, the air valve, which is opened and shut by the working parts of the engine, and has an elastic rod; E, the valve for discharging the air; F, the exhausting pipe, having a free communication betwixt the condenser and the top of the air pump, when the valve D is open; G, the eduction pipe; H, a bucket, and balance valve, for discharging the water down the bored eduction pipe in Fig. 3; I, the delivering valve for water in Figs. 2 and 3; K, in Fig. 1, a bucket for lifting the water upwards as in a common pump; L, a foot valve for preventing the return of the water during the descent of the bucket K; M, the barrel of the pump for discharging water alone; N N, in Fig. 2, an eduction pipe, thirty feet long or upwards, where the water is discharged by its own gravity, and may be attached to the air pump, or condenser, as the dotted lines shew. Fig. 4, exhibiting the principle of the top, stuffing-

ſtuffing-boxes for valves, &c. A A, the cylinder-lid. B B, the top ring that is ſcrewed down with bolts to the flanch of the cylinder. C C, the packing of paper, hemp, or other materials, laid on to the cylinder lid A, and under the top ring B B. D D, a ſhoulder bored in the top of the cylinder, for the lid A to be turned and ground into; this method applies to ſteam cylinders, air pumps, ſtuffing-boxes for valves, as is ſhewn in the other figures. Fig. 5, plan of the working valves and ſide pipes. A A A, the rods that lift the valves. B B, ſtuffing boxes for the valves to work through, fixed in the ſame manner as the cylinder lid in Fig. 4. C C, rings for fixing the ſtuffing-boxes. D D D, mortices for the levers for the opening of the valves. E E, are the two inverted top valves. F F, are reſervoirs for holding oil, or other liquid matter. G G, two circular valve-boxes for admitting the ſteam. Figs. 6, 7, 8, and 9, ſhew the principle of opening and ſhutting the valve by a circular motion. A, the axletree. B, a wheel to be turned from the motion of the fly-wheel, or other parts of the engine or mill-work. C C C C, cranks with rollers fixed upon the axletree A, parallel to each other, or at right angles, as circumſtances may require. D D, circular box rods for receiving alternate motion from the circular motion of the cranks C C. E E, tappet plates for the cranks to work againſt. F F, levers for the mortices D D D in Fig. 5, for lifting the valves. Figs. 8 and 9, ſhew the ſame principle, but differ from the other by having ſtraight plates to work againſt inſtead of circular ones. G G G G, handles for ſetting the engine to work, and may be ſupported at H H H H. The axletrees A A, muſt make the ſame number of

of revolutions as the engine does ſtrokes, which may be eaſily regulated by the wheel-work. Fig. 10, ſhewing the method of connecting the piſton rod to the parallel motion. A, the piſton rod. B, the top cone end of the rod. C, two half ſockets which fit the cone end of the rod. D, the outermoſt ſocket. E, the cone part of this ſocket, fitting the outſide of the ſocket C. F, the cotter for preſſing the rod A, with its ſockets C, into the cone part of the outſide ſocket D, which fixes the whole together as in one piece, without cutting any holes in the rod, as is the caſe in the old method. Fig. 11, ſhewing the method of conſtructing a fire-place for conſuming of ſmoke. A, the boiler. B B B B, brick-work. C, the funnel for conveying coals to the fire. D, ſliding plate for leſſening the aperture of the funnel, and regulating the quantity of coals in. E, the fire-place. F, the grate-bars lying in a frame, and moving upon a joint at No. 1. No. 2, the grate bars lowered down for the purpoſe of cleaning out the fire. G, charging-box for puſhing the fire farther on the grate-bars, and making room for freſh coals as the others are conſumed; this box is filled with holes for the purpoſe of letting air into the fire. H, a ſmall wheel and rack for working the charging-box G in large fires; but the box may be thruſt in by the handle I in ſmall ones. K, a lever for turning the wheel H. No. 3, plan of the grate-bars frame taken out of its place to the pivots that it turns upon when it is lowered to clean out the fire. 4, plan of the charging-box G, to ſhew the method of working it by wheel-work, either by hand, or by a motion from the engine. In witneſs whereof, &c.

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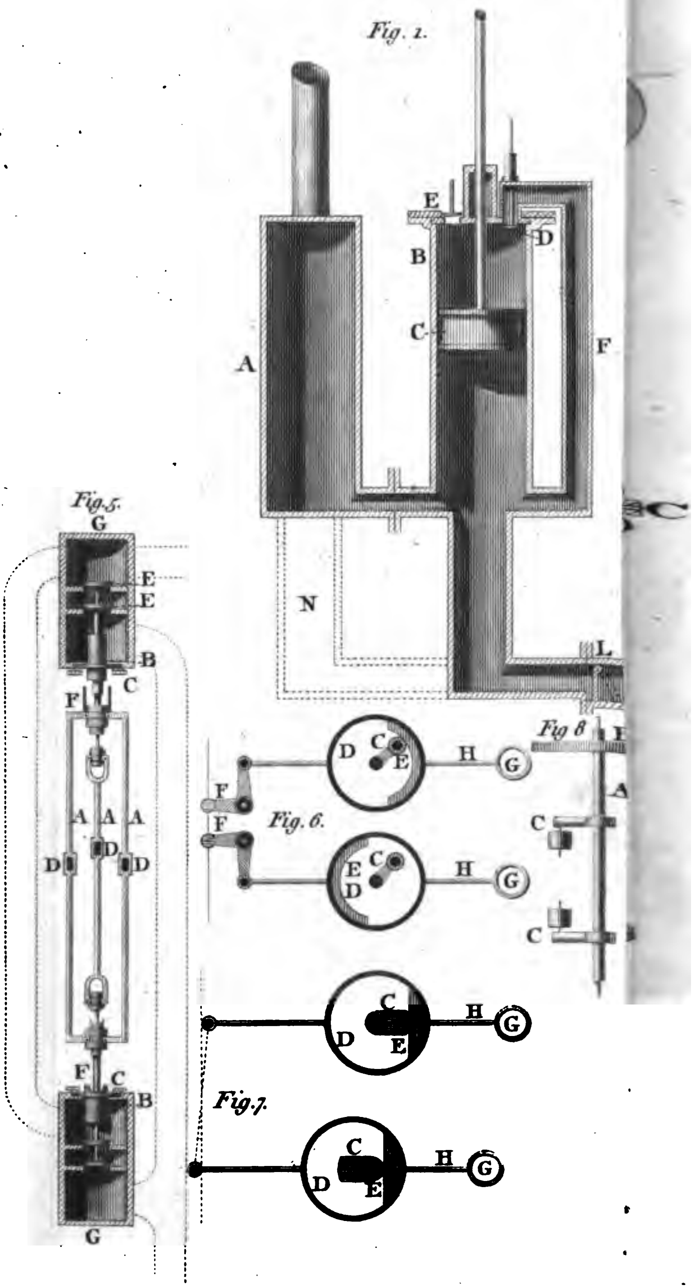


Fig. 1.

Fig. 5.

Fig. 6.

Fig. 7.

Fig 8

L. *Specification of the Patent granted to Mr.* Paul de Philipsthal, *of the Lyceum, in the Strand, in the County of Middlesex, Gentleman; for his Invention of representiug, in a dark Space or Scene, the human Figures, in various Characters, Proportions, and Sizes, and by which Means Painters and other Artists may accurately enlarge or diminish any painting with more certainty and facility than has hitherto been known or done *.*

Dated January 26, 1802.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said Paul de Philipsthal do hereby declare, that my said invention is as follows, *viz.* As the apparition of deceased or returning spirits of men exists rather in the imagination than in reality, therefore every one hath a different conception of the apparitions of ghosts, according to the ideas formed in his understanding. After a diligent search, inconceivable trouble and expence, I have discovered a method, by means of optical experiments, to produce numerous representations of ghostly apparitions, approaching the idea of every spectator, whereby his expectation may be amply satisfied.

The apparatus of some of these exhibitions consists of two concave glasses, or rather two concave metal reflectors, before which an artificial light, proportionable to their focus, is applied.

* This invention is now publickly exhibited under the name of the Phantasmagoria.

These

These enlightened concave metal reflectors are secured in a closet or box proportionable to their size, and their requisite light, in such a manner that all the rays of light are directed upon a transparent picture, representing the apparition; which picture reflects, by means of lenses, upon a transparent body, and giving the necessary direction to this apparatus, according to the nature of its circumstances, in such a manner that the apparitions represent themselves to the eye of the spectator arbitrarily, either in a larger or smaller, in a nearer or more distant perspective point of view.

In the same manner I can likewise represent landscapes and buildings in a very striking and deceiving manner, in a voluntary size.

Another sort of apparition is produced by the refraction of light, by means of transparent bodies, of various shapes and sizes, which are fixed in a dark closet as aforesaid, and, by means of the refraction of an artificial light, are either made visible or invisible. If those bodies are made to liken deceased persons which are required to be seen, then the apparition is the more striking, and answers fully the ideas commonly formed of a spectre.

A third sort of these optical deceptions I produce in the following manner, *viz.*

By opaque moveable figures, of various sizes and shapes. These are moderately enlightened by the refraction of a concave metal reflector, fixed in a dark closet; but the rays of light must be properly distributed by the refraction of a lens, of a proportionable focus, in order that the enlightened object may alone represent itself to the eye; if therefore, according to the description, the

the enlightened figures imitate mechanically the motions of men, and appear in proper drefs or draperies, then this becomes the moft ftriking illufion, as one may by this regulation (by giving an eafy motion to their drapery) produce various groups, and pantomime fcenes, out of the world of fpirits.

A fourth fort of optical illufion is operated in the following manner, in order to produce a multiplicity of apparitions.

There is between the tranfparent body upon which the figures reflect, another dark body flipped in, upon which a fixed number of figures are applied, and are diftributed in a fymmetrical manner; upon thefe figures either a greater or lefs light is directed, according to the difpofition of the groups, and gives to the apparatus the neceffary direction, in order that thofe which reflect upon the tranfparent bodies may move through one another, and form all manner of groups; the pofitions of which are very comic and ftriking, and they procure the moft agreeable entertainment.

Laftly, by means of this briefly-defcribed apparatus and method of working, a thoufand different divertifements and furprifes may be produced, by preparing the neceffary apparatus proportionable to the fpace and place, and poffeffing judgment to moderate the rays of light which would be too extenfive here to be defcribed. Having thus defcribed, and figuratively explained, the nature of my invention, I promife to myfelf, regarding the meritorious difcovery of thefe things, the moft high and gracious protection of his Britannic Majefty, by virtue of his royal letters patent, granted unto me, my executors, &c. In witnefs whereof, &c.

LI. *Account of Experiments to determine the comparative Advantage of the drill or broad-cast Method in the Cultivation of Turnips, and Description of a new-invented Drill. By the Rev.* T. C. MUNNINGS, *of East Dereham, in Norfolk.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal and Ten Guineas were adjudged for this Communication.

RESIDING in a country in which the turnip-crop is very deservedly considered as the basis of its husbandry, I have, for some time, directed my attention, and made some experiments, relative to the improvement of the cultivation of that valuable vegetable; conceiving that in whatever degree I could more advantageously produce turnips, or when produced could provide for a more economical expenditure of the crop, I might fairly be regarded as in the same degree promoting the general and lasting interests of the community. With this view I have made repeated trials, to ascertain "*The comparative advantage of the drill or broad-cast method in the cultivation of turnips*;" and as the result of an experiment which I made last year has not only been satisfactory to myself, but also to all who have witnessed the effects of it, I am induced to offer myself a candidate for the premium held out

out by the Society for the Encouragement of Arts, &c.

But, before I proceed to a detail of my experiments, I think it right to obferve, that I have, *by way of preparation for turnips*, given my land a *deeper* ploughing in the winter than is cuftomary with the neighbouring farmers. For this purpofe, I make ufe of a Scotch foot-plough; and I think that by *fuch* ploughing I bring land into action, which has been for fome time *dormant*; and which is therefore better fuited to the turnip than land which has been exhaufted by the production of other crops. In every other refpect my previous management of my land correfponds with the common practice of my neighbours.

My land *(a field of nine ftatute acres)* being thus prepared, inftead of fowing the turnips *broadcaft* in the ufual method, I invented a DRILL for this purpofe, fimple in its conftruction, and of eafy management. It confifts of a tin box, in the fhape of a barrel, affixed to the axis of a wheel, about twenty-two inches in diameter, vertical with the fame, and in its revolutions dropping the feed through fmall apertures in the middle of the barrel. The holes through which the feed falls are diftant from the wheel about fourteen inches. (See Plate XIV. Figs. 4 and 5, and defcripion thereof annexed.)

I began by having the tops of the different ridges fet out with the common Norfolk *two-horfe plough*; and, when the fame plough took up the furrow next to the top, I immediately followed with my drill, and dropped the feeds upon the frefh mould the inftant it was turned up. I was then followed by a one-horfe plough, the over-fhot mould of which as quickly buried the

 feeds.

feeds. I was thus enabled to fow my feeds as faft as the land was ploughed, and to depofit them in regular and ftraight rows, at equal diftances of about eighteen inches; after which I harrowed or rolled my land, in the fame direction in which it was ploughed; and the confequence has been, that my crop has grown as regularly as a gardener could plant cabbages. Nearly fix acres of my field were thus drilled, and on the fame day (in the third week of June) the remainder of the field, or fomething more than three acres, was fown broad-caft, after the ufual practice of the country, and precifely at the fame time when the farmers around me were fowing their lands in a fimilar manner.

In the courfe of my obfervations on the turnip-crop, I had frequently lamented that, when the crop was indeed abundant, the advantages derived from its expenditure were far from correfpondent, becaufe no effectual method has yet been adopted, to protect the turnips from the feverity of a winter's froft. This, in the common method of *broad-caft* fowing, I confidered as impracticable, and therefore refolved to attempt it in my drilled crop; and in that crop I have been enabled, by pulling up the alternate rows, to leave regular rows about a yard apart, and have had the land fo ploughed, with a one-horfe plough, as to mould up the turnips, on each fide, moft effectually, and to affume the appearance of what is called *two-furrow work*. I have therefore half my crop fo buried, as to leffen very materially, if not abfolutely to prevent, the danger arifing from the frequently fatal effects of a cutting froft.

I am truly happy that the mildnefs of the prefent feafon prevents my fpeaking with greater confidence,

confidence, as to the success of this part of my experiment, though the very complete manner in which the turnips are now buried, leaves me without much doubt but that it fully answers my expectations. Many very experienced farmers, who have witnessed my proceedings, honour them with their entire approbation, and look upon my method of protecting my plants as a grand discovery in the management of the turnip-crop. I am certainly aware, that I am not the first person who has drilled turnips; but I know of no one who has before done it in so simple a manner — in a manner attended with less expence — in a manner admitting of so much ease, in future operations, for the defence of the plants — or in a manner more likely to be clearly understood by all who may be desirous of making similar experiments. Of the superior produce of the drilled crop over the broad-cast, on equal quantities of land, every experiment that I have made has most powerfully convinced me; and I have the universal opinion of all who have viewed my present crop, to confirm my sentiments. It has been observed by Mr. Kent, in his General View of the Agriculture of the County of Norfolk, that the ground does not relish turnips so well as formerly: and he supposes, (in my opinion, with much justice,) that the present comparative ignorance of the use of turnips amongst the Hanoverians, has arisen from the ground in that country being injured by repeated crops of them. It is certainly a very obvious truth, that turnips will grow in the greatest abundance on land not accustomed to bear them: but it has frequently occurred to me, that one material reason of failure, in a crop of turnips sown broad-cast, has arisen from the seed

not

not being ſown ſoon enough after the plough; as I have, in numberleſs inſtances, taken notice of turnips vegetating very partially, when only a few furrows have been ploughed between one ſowing and another; and, in ſuch caſes, I have always thought that, if the ſeed could have been depoſited immediately after the plough, it would not have failed to grow uniformly. I truſt it will be found that my experiment powerfully tends to confirm this concluſion:

In a part of my field, from which the alternate rows have not yet been taken, I have, with very great effect, uſed the hoe-plough, and have not only cut and deſtroyed whatever weeds were growing between the rows, but have alſo partially moulded up the apples of the turnips; and I am induced to believe that even ſo partial a moulding up, executed in the autumnal months, would have a ſtrong tendency to protect the plants, to facilitate a more complete moulding-up when part of the crop is removed, and to admit the full benefit reſulting from the expoſure of the earth to a winter's froſt. I am perſuaded that ſuch uſe of the hoe-plough ſerves likewiſe to retain neceſſary moiſture, and to produce future pulverization with much leſs than common labour. But I have more particularly noticed the very ſuperior verdure of the moulded-up plants, compared with what are not ſo, and with the larger and almoſt uninjured tops of the former, in compariſon with the latter; for, during ſome late froſts, the effects of which were very perceptible in the expoſed plants, thoſe moulded up have continued to grow, and to branch luxuriantly, with all the vigour of vernal vegetation. I attribute this to

the

the bulbs of ſuch plants not having their juices ſtagnated by the keenneſs of the weather.

As I am anxious to have this ſubject fully ſubmitted to the Society for the Encouragement of Arts, &c. allow me to ſay, that I conſider my drill for turnips as much ſuperior to any other, from the ſingle circumſtance of its depoſiting the ſeed ſo *inſtantly* after the plough, as entirely to preſerve the good effects of the firſt evaporation; and that I conceive ſuch evaporation produces the uniform vegetation of ſuch minute ſeeds. So remarkably uniform was the vegetation laſt year, that in the ſix acres of my drilled plants, I believe there was not a deficiency of ſix ſquare yards; though on three acres of broad-caſt, before rain fell, not one half, perhaps not one-third part of the ſeeds vegetated. I am indeed fully perſuaded that the drill method, in the cultivation of turnips, will in all ſeaſons be ſuperior to the broad-caſt; but that the very great and ſtriking difference between the two methods will moſt effectually be perceived in a ſeaſon of uncommon drought; and it is for this reaſon that I am ſolicitous to procure for the drill-method an extenſive and impartial trial, that agriculturiſts in general may be ſatisfactorily convinced of its important advantages.

Of the following advantages attending my method of drilling turnips, I am ſatisfactorily perſuaded: — In a dry time, as was the caſe laſt ſeaſon, the ſeed, by being immediately dropped upon the freſh turned-up mould, has conſequently an increaſed probability of ſucceſsful vegetation. By being buried ſomewhat deeper than in the broad-caſt method, it receives more moiſture in its infant ſtate of vegetation; and by having, if I may

I may ſo ſay, new hold of the earth, is leſs liable to injury, from the effects of continued drought. In confirmation of theſe perſuaſions I muſt ſtate, that turnips ſown on the ſame day, in the ſame field, broad-caſt, on land in every other reſpect treated previouſly in the ſame way, have not produced one-half or one-third of a crop, and that the ſame has been very generally the caſe with turnips ſown broad-caſt; but that every row of my drilled plants has ſucceeded to admiration. The advantages in the ſubſequent management of the crop I have already ſpoken of. If therefore it be deſirable to grow turnips to advantage, if it be deſirable to protect them when grown, and by ſuch protection be enabled to give ſtock, ſound, uninjured turnips, inſtead of what may be more than half-rotten, or froſt-nipt almoſt to putrefaction; I would willingly flatter myſelf that the Society for the Encouragement of Arts, &c. will be convinced that, as far as any concluſion can be drawn from a ſingle experiment in favour of one method rather than another, I have, beyond diſpute, eſtabliſhed the ſuperiority of the drill-method of cultivating turnips.

Of my previous experiments I am not able to furniſh the Society with any ſatisfactory particulars; yet I would by no means omit to declare, that each has been the mean of perſuading me, that the broad-caſt method of cultivating turnips can never be ſo advantageous as that of the drill, when properly managed; and I have much ſatiſfaction in aſſuring the Society, that, from the extraordinary ſucceſs of my laſt year's experiment, many of my neighbours have expreſſed a reſolution to drill, and to protect their turnips for the time to come.

In

In addition to the advantages I have before ſtated, that my drilled plants growing in ſuch very ſtraight and equidiſtant rows, any noxious weeds, ſuch as *charlock*, *thiſtles*, or *red-weed*, may be deſtroyed in the infant ſtate of the plants, by hoeing the intermediate ſpaces; that when the alternate rows are removed, and the land ploughed for the defence of the remaining rows, it receives moſt of the benefits of a winter's froſt, and is very much forwarded in preparation for the barley-crop; and that, above all, from my complete ſucceſs, I have rouſed a ſpirit of emulation in the cultivation of turnips, among the farmers of the county of Norfolk.

With regard to my turnips it would be eaſy to multiply certificates, and be diffuſe in my obſervations, becauſe no agriculturiſt has viewed them without being ſurpriſed both at the abundance of the crop (conſidering the quality of my land), and at the very obvious ſimplicity of my management of it, from beginning to end. I ſhall only farther obſerve, that it is now in my power to ſow my ſeed at equal diſtances of nine, eighteen, twenty-ſeven, thirty-ſix inches, or at any given diſtance of inches, of which nine are an aliquot part; and that I conſider this as no trifling convenience.

Certificates accompanied theſe letters, from Mr. James Blomfield, of Billingford; Mr. St. John Prieſt, Maſter of Scarning-ſchool; Mr. William Salter and Mr. Daniel Reeve, of Beetley; John Tuck and the Rev. George Preſton, Curate of Eaſt Dereham; all which confirm the above accounts.

REFERENCES to Plate XIV.

Fig. 4, A, the wheel with an iron rim.

B, the tin barrel, or seed-box, fixed to the axis of the above wheel.

C, the aperture by which the seed is introduced into the box: —this aperture is afterwards closed by a cover.

D, a semicircular plate of tin, to prevent any dirt falling upon the seed-box.

E, E, the two handles of the machine.

Fig. 5, F, represents the seed-box on a larger scale.

G, the holes in the tin-box, through which the seed falls upon the land.

H, part of the axis of the wheel, to which the seed-box is fixed.

LII. *Description of an Implement in Husbandry, called a Cultivator, by the Inventor, Mr.* WILLIAM LESTER, *of Northampton.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal was presented to Mr. LESTER *for this Invention.*

AS the health and luxuriance of corn depend, in a great measure, on the pulverization of the soil previous to the seed being sown, the Society of

of Arts will, I am persuaded, give every encouragement in their power to the introduction of any implement that promises an abridgement of labour; and as all tenacious soils are pulverized in the best manner in dry weather, when their particles are the most disjointed, and their contact broken, the propriety of taking the advantage of working them in that state will be obvious: and at the same time it follows, that an improved implement for the abridgement of labour would be a desirable thing, in a climate like England, where the seasons are so uncertain.

In working on a rough fallow, my cultivator should be set at its greatest expansion, and contracted in proportion as the clods are reduced. I am confident that one man, a boy, and six horses, will move as much land in a day, and as effectually, as six ploughs; I mean land in a fallow state, that has been previously ploughed.

It will be requisite in some states of the soil to alter the breadth of the shares; but of this, I presume, the farmer will always be a proper judge. By the expansion and contraction of the cultivator, the points of the shares are, in a small degree, moved out of the direct line; but this is so trifling, that it is no impediment to its working.

Description of the Cultivator.

(See Plate XIV. Fig. 1.)

A, the beam. B, B, the handles. C C, a cross bar, of a semi-circular form, containing a number of holes, which allow the two bars D, D, to be placed nearer or farther from each other. D, D, are two strong bars, moveable at one end, upon

upon a pivot E, and extending thence in a triangular form to the cross-bar C. In these bars are square holes, which allow the shares F placed therein, to be fixed to any height required. The seven shares marked F, are shaped at their lower extremities like small trowels: the upper parts of them square iron bars. G, G, G, are three iron wheels, on which the machine is moved; they may be raised or lowered at pleasure. H, the iron hook, to which the swingle tree and horses are to be fixed.

When the machine is first employed on the land, the bars D, D, are expanded as much as possible. As the soil is more loosened, they are brought nearer to the centre: the shares then occupy a less space, and the soil will consequently be better pulverized.

A certificate from Mr. William Shaw, of Cotton-End, near Northampton, accompanied this letter; in which he states that he had used Mr. Lester's cultivator upon a turnip fallow last summer, and that he believes it to be a very useful implement for cultivating the land in a fallow state, by its working or scuffling off seven acres *per* day with six horses. He adds, that from its property of contracting and expanding, it is calculated to work the same land in a rough or fine state, by which means it unites the principles of two implements in one; and, by the index on the axis, it may be worked at any given depth required.

A model of the above described cultivator is reserved in the Society's repository.

LIII.

LIII. *Description of a new-invented Augre or Peat-Borer. By* THOMAS ECCLESTON, *Esquire, of Scaresbrick-Hall, Lancashire.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Thanks of this Society were voted to Mr. ECCLESTON *for this Invention.*

THE greatest obstacle to the effectual draining of many boggy lands, consists in the earth in the bottoms of the ditches or drains when newly cut, and more especially if made to any considerable depth, rising from the pressure of the waters contained in the bog, by which the new-cut drains and ditches are frequently so nearly filled up, as to impede the flowing of the water they were intended to carry off, and thereby rendering the work comparatively ineffectual.

There are different layers, or strata, in moss or peat lands, which will not allow the water easily to filtrate through them, yet are of so soft and spongy a nature as to rise from the pressure of the water contained in the bog.

It becomes necessary to give a free vent to the above confined water, effectually to drain such lands. This has been most successfully done by the augre, a model of which I have herewith presented to the Society.

A common augre, or even a pole, will force a passage, and give vent to the water for a short time; but owing to the peat being only pressed sideways, and not cut out, the parts soon join again,

again, and the paſſage of the water of courſe becomes completely obſtructed; but by means of this augre, a cylindrical column of peat of ſix inches diameter will be clearly cut out and taken thence, and a free paſſage maintained for a very conſiderable ſpace of time.

The firſt experiment made produced a clear augre-hole of the above dimenſions, four yards in depth, in one hour; and the water, which had been pent up in the bog, roſe above the level of the bottom of the ditch, from four to ſix inches; and the bottom of the ditch, which was previouſly very ſoft, and had begun to ſwell and riſe, in a few days became more firm and ſolid, and this in ſo great a degree, that when cleared it remained without ſwelling or riſing in the leaſt. It will conſiderably reduce the expenſe of draining ſuch lands, by rendering them ſo firm as to cauſe the firſt end-drains to ſtand.

The moſt proper depth to bore depends on the ſituation. Where the moſs lands lie low, and are in danger of being flooded, no greater depth than what is abſolutely neceſſary for draining the ſurface ſhould be bored, as, by deep boring the land may be ſunk ſo low as to be liable to inundation.

(References to Plate XIV. Fig. 6.)

A, the cutter of the borer, which penetrates the peat.

B, the body of the borer, ſix inches in diameter.

C, the aperture through which the peat introduced by boring is drawn out.

D, a portion of the iron bar of the borer, to the upper part of which a croſs handle is to be fixed.

LIV.

LIV. *Description of a Drill Machine for sowing Turnip-seed. By* THOMAS ANDREW KNIGHT, *Esquire, of Elton, near Ludlow.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal was voted to Mr. KNIGHT *for this Invention.*

THE small instrument for sowing turnips, which I have sent to the Society, I have tried on several different soils, and think I can venture to assert, that it will sow the seed, and cover it perfectly well, in any soil that is nearly in a proper state to receive it. It is necessary either to harrow the ground *across*, or to roll it, previously to the instrument being used, that the labourer may see the rows he has made; but I have always found the crop to succeed better after the roller than the harrow, though the ground has been very strong.

A, (Plate XIV. Fig. 2,) the iron wheel, which, running on its edge, formed by two concave sides, makes the groove into which the seeds fall. I have sometimes used a wheel with straight sides; but I think that concave sides, when well executed, are to be preferred in strong soils, and indeed in any soil. B, is a wheel, moving on the same axis with A, and turning the wheel C (which

(which gives out the feed) by means of a ftrap. I have feveral fizes of the wheel B, in order to increafe or diminifh the rapidity of C; and confequently to fow more or lefs feed. D, the tube through which the feed paffes, and falls into the channel made by the iron wheel. E, the feet of the inftrument. F, fix lengths of jack-chain; which I find cover the feed remarkably well. The chain is perhaps preferable to any kind of harrow, becaufe it can never become incumbered by loofe ftraw, which is almoft always found on, or clofe to, the furface, when the ground has been manured; and the iron cutting-wheel has a fimilar advantage over any kind of fhare. G the feed-box. H, H, the handles of the machine.

The labour of ufing the inftrument is very fmall. My workman ufually accomplifhes four ftatute acres, or fomething more, in a day: and one night, with the one I fend, he fowed an acre and a half after fix o'clock in the evening. There are two holes before the axis of the great wheel, which point out the proper width of the intervals between the rows. I ufually place my rows at eighteen or twenty inches diftance; and I wifh my plants to ftand at not more than fix inches apart in the row; for I find that three fmall turnips weigh about as much as one large turnip, are more folid, and I think more nutricious, and certainly are much lefs apt to fuffer by unfavourable weather. The ground between the rows is, of courfe, worked with the hoe.

The angle which forms the edge of the wheel A, muft be made more or lefs acute; and the inftrument more or lefs heavy, proportional to the ftrength of the foil. I have fometimes added

weights

Fig. 1.

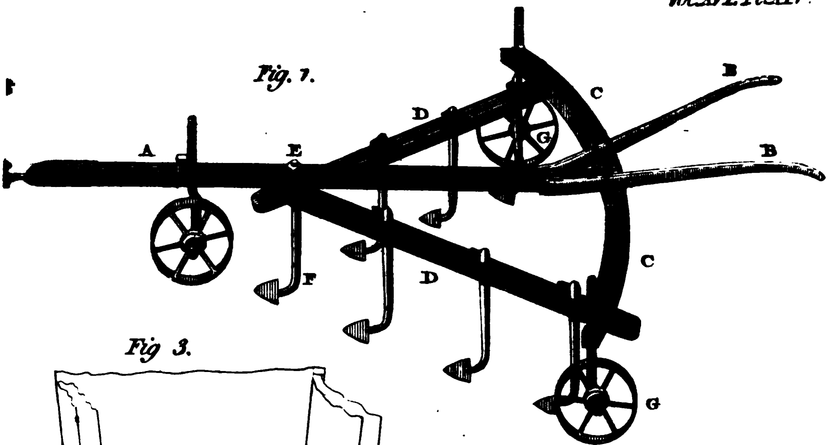


Fig 3.

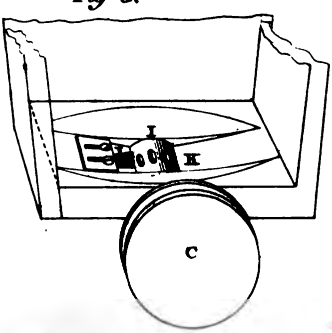


Fig. 2.

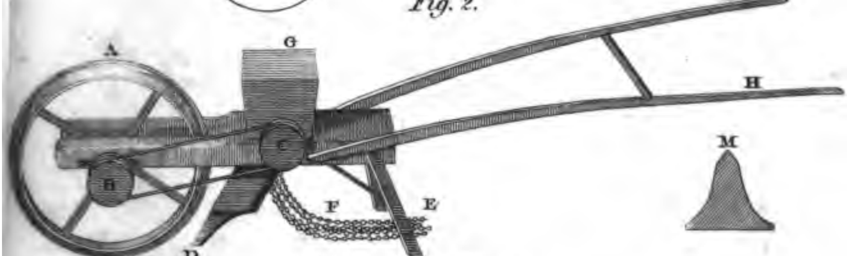


Fig. 4.

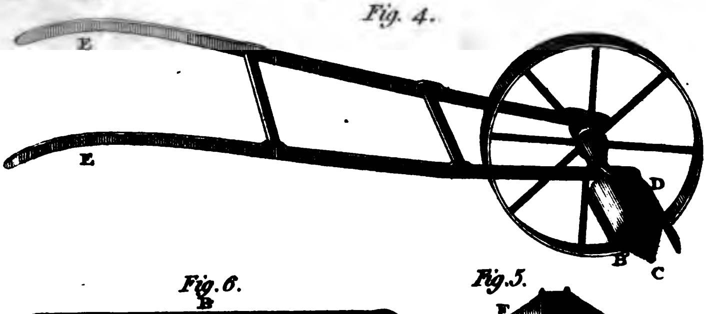


Fig. 6.

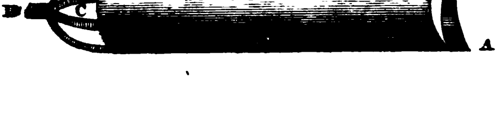
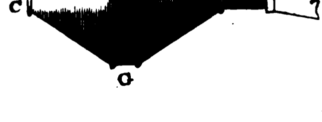


Fig. 5.



weights of lead over the axis of the wheel, but it will rarely be found neceffary. I have tried the inftrument on different foils, and I think it will anfwer on any. A great advantage may be derived by fowing turnips with it, at a time when horfes, now commonly ufed for the fame purpofe, are engaged in other employments. A few days are frequently of importance in fowing turnips, which, by fortunate rains, have got a wonderful ftart of thofe which have been fown a day or two later.

Fig. 3, is a fection, on a larger fcale, of the feed-box G, in Fig. 2. The wheel, marked C, is alfo the fame as in that figure: it is fixed upon the axis of the cylinder I, which is pierced upon the furface with holes at K, for the feed. This cylinder turns round within a groove at the bottom of the box, and is fo well fitted therein, that no feed falls from the box but what is delivered by the holes K. A fmall brufh, marked L, rubs againft the cylinder, to clear out any feeds which may remain in the holes.

The feeds fall into the tube underneath the cylinder, and thence into the channel, made by the indenting rim of the iron wheel.

The loofe chains which follow cover the feeds with earth, as before mentioned.

M, a front-view of the wheel, exhibiting its edge.

This drill machine is placed in the Society's repofitory.

LV. *On a new fulminating Mercury.* By Edward Howard, *Esq. F. R. S.*

(Continued from Page 253.)

SECTION XVII.

I WILL now conclude, by obſerving, that the fulminating mercury ſeems to be characteriſed by the following properties.

It takes fire at the temperature of 368 Fahrenheit; explodes by friction*, by flint and ſteel, and by being thrown into concentrate ſulphuric acid. It is equally inflammable under the exhauſted receiver of an air-pump, as ſurrounded by atmoſpheric air; and it detonates loudly, both by the blow of a hammer, and by a ſtrong electrical ſhock.

Notwithſtanding the compoſition of fulminating ſilver and of fulminating gold, differ eſſentially from that of fulminating mercury, all three have ſimilar qualities. In tremendous effects ſilver undoubtedly ſtands firſt, and gold perhaps the laſt. The effects of the mercurial powder and of gunpowder admit of little compariſon. The one exerts, within certain limits, an almoſt inconceivable force: its agents ſeem to be gas and caloric, very ſuddenly ſet at liberty, and both mercury and water thrown into vapour. The other diſplays a more extended but inferior power: gas and caloric are, comparatively ſpeaking, liberated by degrees; and

* Conſequently it ſhould not be incloſed in a bottle with a glaſs ſtopper.

water,

water, according to Count Rumford, is thrown into vapour*.

Hence it seems that the fulminating mercury, from the limitation of its sphere of action, can seldom, if ever, be applied to mining; and, from the immensity of its initial force, cannot be used in fire-arms, unless in cases where it becomes an object to destroy them; perhaps, where it is the practice to spike cannon, it may be of service, because, I apprehend, it may be used in such a manner as to burst cannon, without dispersing any splinters.

The inflammation of fulminating mercury by concussion offers nothing more novel or remarkable, than the inflammation, by concussion, of many other substances. The theory of such inflammations has been long since exposed by the celebrated Mr. Berthollet, and confirmed by Messieurs Fourcroy, and Vauquelin: yet, I must confess, I am at a loss to understand why a small quantity of mercurial powder made to detonate by the hammer, or the electric shock, should produce a report so much louder than when it is inflamed by a match, or by flint and steel. It might at first be imagined, that the loudness of the report could be accounted for, by supposing the instant of the inflammation, and that of the powder's confinement between the hammer and anvil, to be precisely the same; but, when the electrical shock

* See Philosophical Transactions for the year 1797, p. 222. The hard black substance mentioned by the Count, as remaining after the combustion of gunpowder, must, I believe, have been an alkaline sulphuret, mixed chiefly with sulphite and carbonate of potash. The conjecture, that it is white when first formed, is certainly just, as my experiment with the glass globe evinced.

is ſent through or over a few grains of the powder, merely laid on ivory, and a loud report is the conſequence, I can form no idea of what cauſes ſuch a report.

The operation by which the powder is prepared, is perhaps one of the moſt beautiful and ſurpriſing in chemiſtry; and it is not a little intereſting to conſider the affinities which are brought into play. The ſuperabundant nitrous acid of the mercurial ſolution muſt firſt act on the alcohol, and generate ether, nitrous etherized gas, and oxalic acid. The mercury unites to the two laſt in their naſcent ſtate, and relinquiſhes freſh nitrous acid, to act upon any unaltered alcohol. The oxalic acid, although a prediſpoſing affinity ſeems exerted in favour of its quantity, is evidently not formed faſt enough to retain all the mercury; otherwiſe, no white fumes, during a conſiderable period of the operation, but fulminating mercury alone, would be produced.

Should any doubt ſtill be entertained of the exiſtence of the affinities which have been called prediſpoſing or conſpiring, a proof that ſuch affinities really exiſt, will, I think, be afforded, by comparing the quantity of oxalic acid which can be generated from given meaſures of nitrous acid and alcohol, with the intervention of mercury, and the intervention of other metals. For inſtance, when two meaſured ounces of alcohol are treated with a ſolution of 100 grains of nickel in a meaſured ounce and a half of nitrous acid, little or no precipitate is produced; yet, by the addition of oxalic acid to the reſiduary liquor, a quantity of oxalate of nickel, after ſome repoſe, is depoſited. Copper affords another illuſtration; 100 grains of copper diſſolved in a meaſured ounce

and

and a half of nitrous acid, and treated with alcohol, yielded me about 18 grains only of oxalate; although cupreous oxalate was plentifully generated, by dropping oxalic acid into the residuary liquor. About 21 grains of pure oxalic acid seem to be produced, from the same materials, when 100 grains of mercury are interposed. (See Section XIV.) Besides, according to the Dutch paper, more than once referred to, acetous acid is the principal residue after the preparation of nitrous ether. How can we explain the formation of a greater quantity of oxalic acid, from the same materials, with the intervention of 100 grains of mercury, than with the intervention of 100 grains of copper, otherwise than by the notion of conspiring affinities, so analogous to what we see in other phenomena of nature?

I have attempted, without success, to communicate fulminating properties, by means of alcohol, to gold, platina, antimony, tin, copper, iron, lead, zinc, nickel, bismuth, cobalt, arsenic, and manganese; but I have not yet sufficiently varied my experiments, to enable me to speak with absolute certainty. Silver, when 20 grains of it were treated with nearly the same proportions of nitrous acid and alcohol as 100 grains of mercury, yielded, at the end of the operation, about 3 grains of a grey precipitate, which fulminated with extreme violence. Mr. Cruickshank had the goodness to repeat the experiment: he dissolved 40 grains of silver in 2 ounces of the strongest nitrous acid diluted with an equal quantity of water, and obtained (by means of 2 ounces of alcohol) 60 grains of a very white powder, which fulminated like the grey precipitate above described. It probably combines with the same principles as the mercury, and of course differs from Mr. Berthollet's

thollet's fulminating silver, alluded to in page 230. I observe, that a white precipitate is always produced in the first instance; and that it may be preserved by adding water, as soon as it is formed; otherwise, when the mother liquor is abundant, it often becomes grey, and is redissolved.

P. S. Since the preceding pages were written, I have been permitted, by the Right Honourable Lord Howe, Lieutenant General of the Ordnance, to make the following trials of the mercurial powder, at Woolwich, in conjunction with Colonel Blomefield and Mr. Cruickshank *.

Experiment 1. From the manner in which the screw of the gun-breech, mentioned in Section V. had acted on the barrel, it was imagined, that by bursting an iron case, exactly fitted to the bore of a cannon, its sudden enlargement might make many flaws, and split the piece, without dispersing any splinters. In conformity to this opinion, a cast-iron case was constructed, with a cylindrical chamber, of equal length and diameter, calculated to hold $3\frac{1}{4}$th ounces troy of the mercurial powder. The case, being firmly screwed together, was charged through its vent-hole, and introduced into a twelve pounder carronade, the bore of which it exactly fitted. The powder was then enflamed, with proper precautions. The gun remained entire; but the case divided: the portion forming the upper surface of the chamber, was expelled in one mass; that adjoining the breech, which constituted the rest of the chamber, was cracked in every direction, and in part

* It is with pleasure I take this opportunity of acknowledging the civil attention I received from the different officers.

crumbled;

crumbled; yet it was so wedged into some indentations which the explosion had made in the sides of the piece, that the fragments were not removed without great labour.

Experiment 2. Another cast-iron case was prepared, of the same size as the former, with a chamber also cylindrical, but wrought in a transverse direction, and of a greater length than diameter; the thickness of metal at each extremity not being more than a quarter of an inch. This case was filled with nearly 5 ounces troy of the mercurial powder, and placed in the same carronade. Three twelve-pound shot were next introduced, and brought into close contact with the upper surface of the case, as well as with each other. The gun a second time withstood the explosion: the case was divided across the middle of the chamber, into two equal parts; that adjoining the breech was, as in the former experiment, much flawed, and left immoveable; that nearest to the muzzle was also much flawed, but driven out with the shot. All the three shot were broken; the two lower being divided into several pieces, and the upper one cracked through the centre.

The report was so feeble, in both experiments, that an inattentive person, I am confident, would not have heard it at the distance of two hundred yards.

Experiment 3. It was found so difficult to extract the fragments of the case remaining in the carronade, after the last experiment, that a channel was drilled through them, to the vent-hole of the piece. It was then charged with 6 ounces troy of the mercurial powder, made up as a cartridge, which did not occupy above one half of the diameter of the bore. A wad was placed over the powder,

powder, dry ſand ſuperadded, to fill all vacuities, and the gun filled to the muzzle with two twelve-pound ſhot. A block of wood was ſet at a ſmall diſtance, to receive the impreſſion of the ſhot, and the powder was inflamed as uſual. The carronade ſtill reſiſted. One of the ſhot was ſplit into two pieces; and the block of wood was driven to a conſiderable diſtance, but not penetrated by the ſhot above the depth of one inch. The report was ſomewhat louder than the former ones. In all three inſtances, a conſiderable recoil evidently took place. I preſume, therefore, that in the firſt experiment related in the fifth Section, there muſt have been a recoil, though too trifling to be obſerved; and, in the inſtances where the gun and the proof were burſt, it was not ſo much to be expected.

Experiment 4. Finding that the carronade, from the great comparative ſize of its bore to that of its length, required a larger quantity of mercurial powder to burſt it than we were provided with, we charged a half-pounder ſwivel with an ounce and an half avoirdupois of the mercurial powder (the ſervice charge of gunpowder being 3 ounces,) and a half-pound ſhot between two wads. The piece was deſtroyed from the trunnions to the breech, and its fragments thrown thirty or forty yards. The ball penetrated five inches into a block of wood, ſtanding at about a a yard from the muzzle of the gun; the part of the ſwivel not broken was ſcarce, if at all, moved from its original poſition.

Experiment 5. One ounce avoirdupois of the mercurial powder, encloſed in paper, was placed in the centre of a ſhell, 4,4 inches in diameter, and the vacant ſpace filled with dry ſand.

The

The shell burst by the explosion of the powder, and the fragments were thrown to a considerable distance. The charge of gunpowder, employed to burst the shells of this diameter, is 5 ounces avoirdupois.

Experiment 6. A sea grenade, 3,5 inches diameter, charged like the shell in the last experiment, was burst into numerous fragments, by $\frac{1}{4}$ of an ounce avoirdupois of the mercurial powder. The fragments were projected with but little force, and only to the distance of eight or ten yards. The charge of gunpowder required for grenades of this size, is 3 ounces.

Experiment 7. A sea grenade, of the same diameter as the last mentioned, and charged in the like manner, with $\frac{1}{8}$ of an ounce avoirdupois, or $57\frac{1}{2}$ grains, of the mercurial powder, was split into two equal pieces, which were not thrown ten inches asunder.

The report in the four last experiments was very sharp, but not loud in proportion.

It seems, from the manner in which the swivel was burst, in the fourth experiment, that a smaller charge would have been sufficient for the purpose. We may therefore infer, both from this instance, and from the second experiment made with the gun in Section V. that any piece of ordnance might be destroyed, by employing a quantity of the mercurial powder equal in weight to one half of the service-charge of gunpowder; and, from the seventh and last experiment, we may also conclude, that it would be possible so to proportion the charge of mercurial powder to the size of different cannons, as to burst them without dispersing any splinters. But the great danger attending the use of fulminating mercury,

on account of the facility with which it explodes, will probably prevent its being employed for that purpose.

In addition to the other singular properties of the fulminating mercury, it may be observed, that two ounces inflamed in the open air seem to produce a report much louder than when the same quantity is exploded in a gun capable of resisting its action. Mr. Cruickshank, who made some of the powder, by my process, remarked that it would not inflame gunpowder. In consequence of which, we spread a mixture of coarse and fine-grained gunpowder upon a parcel of the mercurial powder; and, after the inflammation of the latter, we collected most, if not all, of the grains of gunpowder. Can this extraordinary fact be explained by the rapidity of the combustion of fulminating mercury? or is it to be supposed (as gunpowder will not explode at the temperature at which mercury is thrown into vapour) that sufficient caloric is not extricated during this combustion? From the late opportunity I have had of conversing with Mr. Cruickshank, I find that he has made many accurate experiments on gunpowder; and he has permitted me to state, "that the matter which remains after the explosion of gunpowder consists of potash united "with a small proportion of carbonic acid, sulphate of potash, a very small quantity of sulphuret of potash, and unconsumed charcoal. "That 100 grains of good gunpowder yielded "about 53 grains of this residuum, of which three "are charcoal. That it is expremely deliquescent, "and, when exposed to the air, soon absorbs "moisture sufficient to dissolve a part of the alkali; in consequence of which, the charcoal

"becomes

"becomes expofed, and the whole affumes a "black or very dark colour." Mr. Cruickfhank likewife informs me, that after the combuftion of good gunpowder under mercury, no water is ever perceptible.

LVI. *Method of procuring good Water from Wells.*

FROM THE *DECADE PHILOSOPHIQUE, &c.*

IF you wifh the water of a well to be clear, and free from any difagreeable tafte, the excavation fhould be made confiderably larger than is ufually done.

If, for example, you wifh to conftruct a well five feet in diameter, the excavation ought to be from twelve to fifteen feet. A falfe well is made ten or twelve feet in diameter; in the middle of this large well the real well is conftructed with a diameter of about five feet, but in fuch a manner that the water may filter through the interftices left between the ftones, which form the outfide of the inner well: the falfe well is then filled with fand and pebbles, fo that the water muft firft filter through them before it reaches the real well. By this method you are fure of having filtered water perfectly clear and fit to drink.

This operation is rather expenfive, it is true; but the expence is amply compenfated by the advantage of having limpid and wholefome water.

LVII. *On extracting Copper and Tin from the Scoria of Bell-Metal.*

FROM THE *ANNALES DE CHIMIE.*

THE claſs of mathematical and phyſical ſciences of the Inſtitute commiſſioned citizens Guyton, Deyeux, Vauquelin, and Sage, to draw up an account of the operations of citizens Anfrye and Lecour, for the purpoſe of extracting copper and tin from the ſcoria of bell-metal.

It is known, that theſe ſcoria were thrown away as unſerviceable; that roads were made with them, and that they were uſed at Romilly, near Rouen, for making a dyke: but citizen Anfrye, who has made metallurgic chemiſtry his principal ſtudy, has ſucceeded by a dry proceſs, in extracting, from theſe ſcoria, from 30 to 40 pounds of tin and copper *per* quintal.

The operation by which the copper is ſeparated from the ſcoria of bell-metal, is performed only by the oxidation of the tin contained in them; afterwards, in order to ſeparate the oxid of tin from the copper compriſed in it, recourſe is had to waſhing.

Citizens Anfrye and Lecour have informed us, that to reduce the oxid of tin, it is neceſſary to mix with it an eleventh part of powder of charcoal; that a greater or leſs quantity is injurious to its reduction, which they performed in our preſence, by fuſing in an air-furnace 500 grammes of oxid of tin, with 55 grammes of pulveriſed charcoal. The reduction was completed in half an hour, and produced tin comparable to that of England.

The

The tin in paſſing into the ſtate of white oxid encreaſes 40 pounds *per* quintal, thus the oxid of this metal produces only 60 pounds of tin by the reduction.

Citizens Lecour and Anfrye operated, in our preſence, the reduction of oxid of tin on a large ſcale, by fuſing, in a heap, in the furnace, with charcoal, this oxid of tin mixed with an eleventh part of pulveriſed charcoal; care was taken to wet this mixture a little previous to its being thrown into the furnace, that part of the oxid of tin might not be carried away by the wind from the bellows.

The tin produced by this reduction is as pure as what was obtained by the reduction in the laboratory of citizens Anfrye and Lecour.

This tin is much purer than that of the ſhops, which was uſed in the firſt experiments; which tin is ſupplied by the dealers in the departments, and is refined at preſent in Paris. A bar of this tin of the ſhops, three lines in diameter, having been filed away about half a line, and bent on the corner of an anvil, broke, and preſented a cloſe, greyiſh grain, ſimilar to that of a mixture of pure tin, with a ſixth part of antimony, which induced one of the commiſſioners, citizen Sage, to aſſert, that the tin extracted from bell-metal derived its grain from that ſemi-metal.

In order to determine whether it contained any, 100 parts of this tin of the ſhops was diſſolved in about 400 parts of muriatic acid mixed with a fourth of nitric acid: when the diſſolution was completed, there remained but a ſmall quantity of copper under the form of a black powder.

English tin, and likewiſe that of the citizens Anfrye and Lecour, being diſſolved by the muriatic

riatic acid mixed with one fourth of nitric acid, left about a two hundredth part of copper under the form of a black powder, which being fused upon charcoal with borax, produced a grey, brittle, metallic substance, being a mixture of tin and copper; when dissolved in nitric acid, it assumed a blue colour, which was rendered much deeper by ammoniac.

The dissolutions of these three kinds of tin, being put into distilled water, did not make it turbid. The same was not the case with the dissolution of tin mixed with a twelfth part of antimony; being put in water, it assumed the appearance of milk, and precipitated white oxid of antimony.

It remained to be determined, what makes the tin of citizens Anfrye and Lecour firmer, what diminishes its sound, what causes it to have a more dull colour, whence it has the property of breaking and presenting a fine, greyish grain, which cannot be attributed to its cooling being more or less accelerated, or to a more or less violent heat for the fusion of this tin, as it has been run off in every state, and bars of it have always proved brittle, whilst the pure Malaca tin bends without breaking, or presenting any grain.

Citizen Sage, persuaded that the grain of tin was solely the effect of alloy, and recollecting that he had seen brass mixed with the tin and copper, for the composition of bell metal, endeavoured to ascertain whether the brittleness of the tin extracted from it was not caused by zinc: he mixed, by fusion, Malaca tin with zinc in various proportions; the mixture with a twelfth part of zinc still resembled the brittle tin of the shops of Citizens Anfrye and Lecour: it dissolved just

just in the same manner in the muriatic acid mixed with one fourth of nitric acid; distilled water made no alteration in the dissolution; but the experiments that shall presently be described prove that the grain and the brittleness of this tin are owing to lead, which would not at first be imagined, considering the softness and pliability of that metal. Before we proceed to an account of the experiments, we think it our duty to lay before the institute an interesting fact, communicated to us by Messrs. Volta and Brugnatelli, who told us that it might be instantly determined whether tin contained any zinc; that then it became proper for galvanic experiments and that the smallest portion of zinc was observable by this method. This we ourselves have found by varying this mixture gradually from a twelfth part of zinc to a two hundredth, in which proportion the galvanic effect is still very sensible. Thus natural philosophy is under new obligations to Messrs. Volta and Brugnatelli, since in future this mixture may be substituted instead of pure zinc, for galvanic piles; besides which, this mixture possesses the two-fold advantage of running readily, and of not being subject to oxidate like pure zinc.

The mixture of tin and zinc bears a greater resemblance to silver, in its colour, than tin: therefore it is a similar mixture that is used in Germany for making the paper called in trade *silvered*, which paper M. Volta employs in galvanic experiments, for which tin would not suffice.

We have said, in this report, that the tin we saw reduced by Citizens Anfrye and Lecour was equal in purity to that of England; but we should have observed, that neither of them has the metallic ring of Malaca tin, which is the purest

pureſt hitherto known. A bar of this tin 3 lines in diameter and 6 inches long, having been filed away about half a line, and afterwards bent on the corner of an anvil, required bending backwards and forwards 20 times before it broke, and then preſented only fibres and no grain. This is not the caſe with Engliſh tin, nor with that of Citizens Anfrye and Lecour; under the ſame circumſtances as above, the bars broke at the third bending and preſented a grain, which muſt be attributed to the lead they contain.

Malaca tin, alloyed with a ſixth part of lead, aſſumes a grey colour, becomes hard, and, when broken, preſents a greyiſh grain. The ſame tin, alloyed with a twelfth part of lead, is leſs grey, as well as the grain it preſents when broken.

Upon pouring on one hundred parts of this alloy four hundred parts of nitric acid, it diſſolved the lead, and oxydated the pewter. This oxid was waſhed with diſtilled water; the lie being made to evaporate in a glaſs veſſel in a ſand-bath, nitrate of lead was firſt precipitated in white cryſtals; the evaporation was continued till dry; the reſiduum weighed the fifth part of the pewter employed; it contained a fourth part of its weight of ammoniacal nitrate, which is formed by this experiment, as was firſt diſcovered by Citizen Guyton.

The refined tin of Citizens Anfrye and Lecour, being treated in the ſame manner with the ſame nitric acid, produced a twelfth part and a half of ammoniacal nitrate, mixed with $\frac{3}{8}$ of nitrate of lead.

Engliſh tin, treated in the ſame manner, produced exactly the ſame quantity of nitrate.

Malaca

Malaca tin, having undergone the ſame experiment, left five parts of pure ammoniacal nitrate.

Amongſt the ſpecimens of tin ſent to the commiſſioners by the Citizens Anfrye and Lecour, there are ſome of two different qualities; the firſt, denominated that of tne ſhops, breaks without trouble, and preſents a greyiſh grain, produced by the copper and lead it contains; being ſubjected to the operation of the nitric acid, like Engliſh tin, and having in the ſame manner waſhed the oxid of tin with lie, and made this diſſolution evaporate, it aſſumed an emerald green hue, and a ſmall quantity of nitrate of lead was precipitated from it. The diſſolution being evaporated till dry, left twelve parts of nitrate of verdigris, ſo abſorbent of humidity that it fell into deliquium in leſs than half an hour, and inſinuated itſelf, as well as the ammoniacal nitrate, into coarſe paper, upon which were left two parts of nitrate of lead. Thus it is to a three-fold mixture of copper and lead that the firſt tin of the ſhops of Citizens Anfrye and Lecour owes its qualities.

After the experiments detailed in this report, the commiſſioners think they may aſſert that Malaca tin is the pureſt hitherto known; that Engliſh tin, and likewiſe the tin purified by Citizens Anfrye and Lecour contain,

98 parts of pure tin,
1 part of lead,
one two-hundredth part of copper.

The beſt tin of the ſhops contains,

96 parts of tin,
3 parts of copper,
1 part of lead.

 Citizens

Citizens Anfrye and Lecour, by restoring to commerce, by means of their discovery above 1,500,000 lbs. of tin, and two millions of copper, appear to us to deserve the praises of the institute, and the particular notice of government.

We think it our duty likewise to mention to the institute another advantage which Citizens Anfrye and Lecour have rendered to the arts: namely, the oxid or ceruse of tin, which, after being well washed, is as capable as that of England of giving a high polish to steel. A trial of it was made in the presence of the commissioners.

LVIII. *Observations on dying with Madder, followed by a simple and invariable Process for obtaining, in its greatest beauty and solidity, the Colour known by the appellation of Levant or Adrianople Red.* By JEAN MICHEL HAUSSMAN *.

FROM THE *ANNALES DE CHIMIE.*

I HAVE already shewn in the *Annales de Chimie* and *Journal de Physique*, that metallic earths and oxids

* We ought not to omit mentioning that Citizen Chaptal, minister of the interior, such an excellent judge of these matters, wrote to us at the time he sent these observations. The following are the terms of his letter. "Citizen Haussman, manufacturer of painted cloths at Loglebach, near Colmar, in the department of Upper Rhine, well known amongst those chemists who apply the discoveries of Sciences towards

oxids possess neither in a greater nor less degree the property of attracting or retaining the colouring parts of vegetable and animal substances; alum and oxid of iron possess it more powerfully than oxid of tin, the power of attraction of the latter, nevertheless, far surpasses that of other metallic earths and oxids, as far as regards the colouring parts of the said substances.

Alum, as well as metallic oxids, does not retain with the same power of adhesion the colouring parts of all vegetable and animal substances indiscriminately; those of madder adhere more strongly than of other colouring substances which may be classed in the following order: grains of kermes, cocheneal, campeachy wood, yellow India wood, woad, quercitron, fernambuc wood, red India wood, Avignon nuts, &c. Gall nuts, sumach and other astringent, colouring substances act principally by means of the gallic acid, and may, with regard to their degree of solidity, be placed immediately after madder: it is not the same with Prussian acid, which colours different metallic oxids, from which it may be extracted when cold by alcaline lyes.

To judge of the solidity of the colours produced by vegetable and animal substances, the best method is to make use of a lye of oxygenated muriate of pot-ash, or of soda with alcaline carbonate. The longer or shorter resistance which the colours make in this lye will shew what they will do, if acid, alcaline, soapy and other counter-agents are employed.

towards perfecting the Arts, has addressed to me the annexed memoir. I thought it would be of service to make it known through the medium of your annals, and at my request the author has consented to its publication.

In the art of dying and manufacture of printed calico, by staining with madder (garançage) is understood the process whereby the colouring particles of the madder are transferred by the alum or oxide of iron, attached to any kind of stuff whatever by means of water assisted by heat.

The brightness and solidity of colours obtained from madder, depend not only on the management, but likewise on the state of the purity of the water, as well as of the madder. It is therefore absolutely necessary to avoid or to render inactive every acid, alkaline, or saline substance, that may be contained in the water or madder itself. I have shewn that by means of the addition of carbonate of lime (pulverised chalk) you may correct the madder, which I had imagined, contained the gallic acid, but which my friend Charles Bertholdi, professor of the central school of the Upper Rhine, afterwards discovered to be sulphuric acid in conjunction with magnesia.

The important discovery of this addition of chalk, which I made 25 years ago, has given birth to many fabrics, and has brought to perfection all those established near waters which do not carry with them or retain in a dissolved state, that earthy salt without which it is absolutely impossible to obtain bright and solid colours from madder. This chalk has, since that period, become a new article of commerce, and as its price is very moderate, I have not yet determined the exact proportion to be used; I usually take one part to 4, 5, and 6 parts of madder.

In order to obtain the colours of madder of a perfect brightness, it is not sufficient to attend to the quality of the water and of the madder; it is likewise

likewise of importance to observe the degree of heat of the bath. A low temperature will retard the extraction and attraction of the colouring particles, whilst, on the other hand if too high, it, at the same time, promotes the adhesion of the dark particles of the madder which tarnish and obscure the tints intended to be produced; black only is improved by augmenting the heat. I have invariably observed that by taking the fire from under the cauldrons, as soon as one can no longer bear to hold one's hand in the liquid they contain, and afterwards suffering the dye to remain two or three hours, one procures the most satisfactory results: for the copper then retains a sufficient heat to keep the liquid at the same temperature, particularly when, according to custom, large cauldrons are used. It would otherwise be extremely difficult to fix a degree of heat, by means of thermometers, with spacious furnaces.

The dusky particles of madder as well as of other colouring substances, are probably only parts of the colouring substances themselves combined with oxygen. The produce of this combination, although it acquires a greater degree of solubility, proves, nevertheless, more difficult to be removed in the finishing, if the heat has not been properly attended to in dying. I have frequently observed, that madder and other colouring substances, after being long exposed to the atmospheric air, no longer afforded such deep and bright colours as before, either because these substances absorb the oxygen of the atmosphere, or because this essential is supplied by the water which they attract, or naturally contain as a constituting principle, and which is de-

composed

composed by a slow and imperceptible fermentation. A piece of cotton or linen cloth dyed red, heightened with madder, and exposed in a field, may confirm the idea of its changing to a dusky hue; but this deep colour becomes clearer and clearer, after growing dull, and at length assumes a more agreeable crimson tint. in the finishing. I have demonstrated in a Memoir on Indigo, inserted in the *Journal de Physique*, of the year 1788, that the nitric acid changes this blue sediment to a yellowish substance. A similar change takes place in exposing in a field this same sediment attached to any kind of stuff whatever, and the yellow that results from both methods is more soluble in warm water than in the same liquid when cold. It appears however, that the combination of the oxygen is not the only cause of the changing of the colours, for curtains of any kind of stuff dyed, or coloured in any manner whatever, by vegetable or animal substances and exposed to the day light, lose their colour entirely, in process of time, on the side exposed to the rays of the sun, whilst the opposite side preserves the same colour for a great length of time. Although therefore, the sun's rays give more vigour to the animated bodies of the animal and vegetable kingdom, by disengaging from them the oxygen gas, yet they appear to act destructively on the same inanimate bodies, by decomposing their constituting principles. At any rate, it will be the best way to keep colouring ingredients in dry places and covered up from the light, which probably acts no otherwise on these bodies, than by decomposing the aqueous constituting part, whose two essential principles may transfer themselves to the

the carbone, to form carbonic acid and likewise other resinous and oily substances. These conjectures prove, at least, that the action of the sun's rays, or more properly of light on bodies in general, presents an extensive field for interesting experiments.

If, in dying with madder we obtain more lively colours by a careful management of the heat, we, at the same time, sacrifice a small portion of the colouring particles of the madder, which cannot be entirely exhausted, except by adding thereto gall-nuts or sumach, and afterwards augmenting the heat to ebullition: but as the colours obtained by this method fade more or less in proportion to the quantity of the madder, of the gall-nuts, or of sumach, it must not be used but with precaution and principally for common purposes, for calicoes, cotton yarn, or thread. To prevent, as much as possible, the waste of madder, one might, after having finished dying the articles of value, and before the common ones are put into the cauldron, add thereto gall-nuts or powder of sumach, with a fresh and small portion of madder; attention must then be paid not to suffer the ebullition to take place till two hours after.

TO BE CONCLUDED IN OUR NEXT.

LIX.

LIX. *On a new Method of preparing radical Vinegar.*

FROM THE *ANNALES DES ARTS ET MANUFACTURES.*

WE have lately received ſome directions for the making of vinegar denominated *radical vinegar*; as they preſent ſome new facts and methods of preparation that deſerve to be known, we ſhall give them as we receive them from our correſpondent.

The experiments that taught me, three years ago, the real diſtinction between the *acetic* and *acetous* nature of acids, ought not, I think, to be loſt to the arts. I gave an account, in part, of their reſults, in a memoir inſerted in the number of the *Journal de Phyſique* for Vendemiaire, in the year 8, but new experiments, made in the laboratory of the unfortunate *Moſcati*, perfected my former obſervations, and I now offer to your journal two proceſſes for making, in a more œconomical and ſafer manner, the liquid known at the toilette and in apothecaries' ſhops by the appellation of *radical vinegar.*

It has always been uſual to extract it by gradual diſtillation from cryſtals of copper, in earthen veſſels, in a reverberatory furnace. This violent heat, giving to the fluid an extraordinary expanſion, frequently cauſed diſagreeable accidents; it even deſtroyed great part of it, which occaſioned the great quantity of carbonic acid, that chemiſts had always noticed, without being able to explain how it was formed; the part ſaved was always intermixed with particles of copper, which

were

were the more difficult to extract from it as that metal has a great affinity with the acetic acid. The new chemistry did not correct this process because it had long considered as essential to the formation of the acid what in fact is only an inconvenience arising from the defect of manipulation.

My first process, which consists simply in pouring one part of concentrated sulphuric acid to one of acetite of copper, and distilling it on a sand-bath, remedies every inconvenience, and prevents all danger attendant on manipulation; this was the process I published in the *Journal des Pharmaciens*, of which Citizen Fourcroy was then the editor: it appeared of sufficient consequence to be inserted in the *Manuel du Chemiste*.

It was in Italy that I conceived the idea of the second, during the severe winter of the year 7. I, at that time, made many experiments on the action of cold on vegetable acids; and comparing this action on the acetous acid with that of the sulphuric acid, I observed that both of them acted in the same manner, with respect to this liquid. I discovered, by means of this extraordinary similarity, that the reverberatory furnace produced radical vinegar, and that extreme cold produced it likewise. Many explanations resulted from this piece of discovery, and I shall probably soon be able to bring to light an infinite number of others not to be found either in the *Journal de Physique*, or any where else.

I confine myself to what is merely practical. I take a kilogramme of white vinegar concentrated by the frost, I pour to it half a kilogramme of concentrated sulphuric acid, and distil the mixture

ture in a fand-bath, till the vapours of the fulphureous acid begin to appear. I obtain a light and ftrongly-fcented liquid; but I confefs this liquid requires diftilling a fecond time before it is the real radical vinegar.

This procefs, it is obvious, is fimple, and the refiduum expofed to a fudden heat may ferve a fecond and a third time; and by encreafing the quantity of fulphuric acid one half, the vinegar need not be expofed to the froft. It is true, the fecond diftillation will greatly augment the expence. Artifts will afcertain whether this expence be as heavy as that incurred by the ordinary procefs, wherein acetite of copper is ufed: I think not. It is at leaft certain, that my acetic acid may be ufed without thofe apprehenfions caufed by that now fold. Let females, who only ufe it as a luxury, reflect, that when refpiring its odour, they introduce into their lungs more or lefs copper, one of the moft POWERFUL POISONS, and they will be the firft to difcountenance the former procefs, in order to introduce thofe which I propofe.

As the produce from both is not liable to any kind of fufpicion, the only point is to calculate which of them, being attended with the leaft expence, deferves the preference. This calculation I leave to the artifts who read your journal, to which I confign them.

LX. *Description of a Stove, on the Principles of those used in Sweden, with Apertures emitting heated air.* By CITIZEN GUYTON.

(Concluded from Page 258.)

SAVOT, in his *Architecture Françaiſe des Batimens particuliers*, printed in 1625, gave ſome advice relative to the beſt method of conſtructing chimneys; but with ſcarcely any other object than to prevent their ſmoking.

Daleſme, in 1686, ſuggeſted the firſt idea of a ſtove without ſmoke, which he called *furnus acapnos*. Here the ſmoke is forced to deſcend into the fire-place, where it is conſumed. Dr. Franklin, who afterwards executed it, ſtill ſpoke of it in 1773 as a mere curioſity, or philoſophical experiment,—as it required too much attention to be managed by common ſervants.

Gauger, author of *La Méchanique du feu, &c.* printed at Paris in 1713, was the perſon to whom we are indebted for the firſt and moſt complete ſyſtem of experiments on the circulation of heat, air-holes affording warm air, the manner of making one fire warm ſeveral rooms, and to ſend off the heat in elliptic curves. We there find a deſcription of a chimney with the back, the hearth, and the jambs, of hollow iron, to heat the air that is to enter the room. But it does not appear that this work produced much effect at the time. The moſt important truths lie concealed in books, till ſome preſſing intereſt awakens the attention of mankind to their utility.

 Dr.

Dr. Franklin, in 1745, published an account of the new stoves of Pennsylvania, the advantages of which he compares with those of the stoves of Germany and Holland, and the chimney of Gauger. On these principles are constructed the œconomical fire-places of Citizen Désarnod.

Necessity naturally rendered the inhabitants of the North more industrious in this respect than those of more temperate climates; and hence we long neglected even to enquire into their contrivances to warm their apartments. To Montalambert is attributed the first idea of introducing into France stoves constructed in imitation of those used in Russia, in which the smoke circulated in ascending and descending flues. In the memoir he read on that subject to the Academy of Sciences in 1767, he called them *Cheminées-poëles*. Several of these were executed at Paris, and even Russian workmen brought thither, in order more surely to obtain every advantage their method afforded.

Since that time these stoves have been much varied by giving many circumvolutions to the flues for the smoke. However, as Berthollet observed, in a report made to government in 1787 on Jouvet's œconomical stoves, and which he communicated to me, "we rarely hear the true "principles laid down that ought to regulate this "distribution." Most of the stove-builders were not then aware of "the necessity of exposing the "circumvolutions to a vivid heat.—They con-"founded this method with that of the Russian "furnaces, where the flue by which the smoke "escapes immediately goes off to a distance "from the fire-place—so that the smoke is so "much

" much cooled as not to be consumed with the
" air; and by this construction the heat is merely
" retained which would have been dissipated
" with the smoke."

But it is otherwise in the Swedish stove, in the descriptions of which that have reached us we find the most exact application of the true principles, and especially the most favourable disposition of the flues for the circulation of the smoke, in order to effect its perfect combustion.

These descriptions may be seen in a work printed at Stockholm in 1775, entitled, *Samling af Beskrifningar, &c.* or a Collection of Descriptions of various Fire-places contrived to œconomise wood, 4to. forty pages, with nineteen plates.

It appears, from the preliminary discourse, that, so long ago as 1767, Count C. J. Cronstedt, President of the Royal College of Finances, had been appointed to publish an instruction on the manner of constructing stoves, furnaces, and chimneys, of every kind, so as to œconomise fuel; and that Baron Fabian Wrede, who had for several years studied this subject, and had already succeeded in reducing the consumption of wood to one half, had communicated to him the result of his labours and experiments. M. Palmstedt, architect, of Stockholm, who executed the designs, and gave the explanations of them, allows him the merit of inventing the six first.

These descriptions are followed by those published about the same time by Baron Carl Sparre, which are likewise accompanied with designs and explanations of Palmstedt, whom the author of this part represents as having particularly contributed to put in practice these useful inventions.

It

It would be digreffing too much from my fubject, here to particularize thefe ftoves and furnaces, fome of which have 4,5, and even 9 flues of circulation for the fmoke; fome of the fimpleft conftruction, others in the form of columns of various fizes, more or lefs decorated, according to their deftinations, and fome contrived to receive one or more boilers, and advantageoufly employed in various manufactures for dying, brewing, &c. I fhall only make a few obfervations capable of general application, or calculated to enforce the importance of the endeavours that have been made to accelerate this revolution in the method of warming apartments, and the advantages that have been thence derived.

It appears, that only of late years chimneys and ftoves *with large openings*, as Count Cronftedt called them, (open fire-places,) have been ufed in Sweden; and he admits, that they have the advantage of permitting the fire to be feen *; but he fhews the neceffity of abandoning that practice in confequence of the progreffive diminution it had caufed in the forefts, which threatened fucceeding generations with a total want of fuel. It is from humanity and patriotifm therefore that he calls the attention of the middling and higher claffes to this reform.

An experiment of nine weeks, from the tenth of December to the eighteenth of February, convinced him, that the fame quantity of the fame wood, which in one of thefe new ftoves had during that interval maintained an equal heat in

* Dr. Franklin mentions, as one of the motives for preferring the Pennfylvanian ftove, that the company are not deprived of the pleafure of feeing the fire.

an apartment, had been consumed in twenty-three days in a common open chimney or stove, though it gave much less heat, and Baron Sparre even then declared, that in *several thousand* houses, in which that ardent patriot had caused the new stoves to be erected, a saving had arisen of 30 a 40 *per cent.* This saving, according to Palmstedt, has sometimes exceeded one half, and always with a heat more equal, and better kept up, than had been before experienced *.

These testimonies appear to me calculated to fix the attention of the public on the advantages to be expected from the Swedish stoves. It is well known by the accounts of travellers, that the cold felt in Sweden during a common winter exceeds by several degrees that of our most severe winters in France; and yet in no country do the inhabitants defend themselves from the inclemency of the season at a smaller expense. But though these facts are well known, we cannot accumulate too many documents and proofs, when we would convert a vague tradition into a certain conviction, and induce mankind to abandon any ancient long-established custom.

As to the construction of these stoves, the authors I have quoted observe, that it costs very little, saves much of the iron formerly employed, and only requires bricks or square tiles.

They recommend laying them on their broadest side (de champ), to choose them as thin as pos-

* I have heard these facts confirmed by Count Scheffer, long prime minister to the King of Sweden, who assured me, when he passed through Dijon on his return from the waters of Bourbonne, that this method having become general had really produced a diminution of one-third in the consumption of wood.

sible

fible for the interior walls, and to place the circulating flues so that the rain that falls down the flues of the chimney may never find its way into them.

They also give some directions relative to the feeding these stoves, which is so easy, that in the largest public establishments a single individual lights all the fires. This supply consists in putting in as much wood as the fire-place, which is very small, will hold, in only introducing sawed wood of equal length, and as soon as it is burnt shutting the slide that cuts off the communication of the circulating flues with the chimney flue; by which means all the heat the fuel has produced is retained in these channels, escaping slowly, and so as only to spread itself through the apartment; whereas any piece of wood that could not have burnt out in an equal space of time would require the slide to continue open, and the current of air necessary for its combustion would carry off, through the flue of the chimney, the greater part of the heat at first produced.

It was after having collected all these instructions, that I caused the stove to be built, which I am now about to describe.

References to Plate XV.

Fig. 1, represents a front view of the stove, its height being 164 centimeters, or about 61 inches French, exclusive of the vase, which is merely an unconnected ornament standing on the flat surface at top.

Its breadth is 85 centim., or about 31½ inches French.

Its

Its depth is 58 centimeters, or about 21½ inches French.

The height may vary according to that of the room, and may without inconvenience be extended to two metres. It may also be reduced, as I have myself practised, for a laboratory-stove, which ought to have a sand-bath breast-high.

The two other dimensions are determined by those of the bricks employed in constructing the internal circulating flues, which bricks ought to be in certain fixed proportions, that the smoke may pass freely, and yet that it may not be accompanied by a quantity of air sufficient to condense it, or to lower the temperature below the degree of heat requisite for its complete combustion.

V V, the external furniture of the two heating apertures.

m m, apertures where the air enters, which afterwards issues from the heating apertures. These are closed whenever the air is brought in from without by a connected tube under the floor; which is far more favorable to the renewal of the respirable air of the apartment, and prevents the danger arising from currents of cold air attracted by the fire-place; which becomes necessary, as I have said before, whenever the volume of air in the apartment is insufficient to supply at once the consumption of the fire and the circulation in the heating tubes.

Fig. 2, is the plan of the foundation of the hearth at the line A B in Fig. 1.

l, *l*, are the vacancies to receive and conduct the air into the compartments where it is to be heated, previous to its issuing from the heating

apertures, whether it be brought from without or through the apertures *m m* in Fig. 1.

Fig. 3, is a plan at the line C D in Fig. 1. that is below the door of the fire-place.

n n, *n n*, the double caſt-iron plates forming the compartments, where the air receives heat from the fire.

o o, vacancies between theſe iron-plates.

Fig. 4, is a front ſection at the line I K in Fig. 3, the darts ſhowing the direction of the ſmoke in the circulating flues in front *.

The iron-plates *n n* are here again repreſented in their perpendicular poſition, with the tongues that form the compartments on each ſide of the fire-place. One of theſe plates is repreſented in front, Fig. 7.

T, is an aperture reſerved at the bottom of the fourth circulating flue, to eſtabliſh, if needful, the draught of air in the fire-place by burning a few ſlips of paper, or other light combuſtible ſubſtance. I ſay *if needful*, becauſe I have found that this precaution may be neglected, as ſoon as the ſtove has been ſufficiently heated to expel all its internal moiſture.

The door of this air-pump, as it were, muſt ſhut accurately. For this purpoſe it is enough to cut a piece of brick, which may be pierced ſo as to receive a handle, and affix upon it a piece of wrought iron as a covering.

* Among the various Swediſh ſtoves deſcribed and repreſented in Baron Cronſtedt's collection, are ſeveral where the circulating flues paſs under the hearth. This certainly affords a larger heating ſurface; but as ſoon as the hearth is covered with aſhes, it communicates but very little heat to the air beneath it. This plan alſo requires the hearth to be placed higher, and renders the conſtruction more complex and more expenſive. For theſe reaſons I adopted the moſt ſimple plan.

Fig.

Fig. 5, is a plan taken at the line E F in Fig. 1.

Fig. 6, is a lateral section at the line G H in Fig. 3, showing the height of the fire-place, and the first direction of the flame.

V shows the disposal of the heating-flues: the dotted lines show in profile the partitions forming the four great circulating-flues.

R the tube that conveys the smoke from the circulating flues into the chimney, being furnished with a key to intercept the communication. This is a common flue-pipe of plate-iron; but it would be more advantageous to use, in that part where the slide or stopple acts, some substance that is a worse conductor of heat, as for instance a pipe made on purpose of earthen-ware.

The angle formed by this tube in its way to the chimney renders it unnecessary to repeat, that the first condition is that the body of the stove be detached from the wall. That which I am describing is 25 centimetres from the nearest point of the niche where it stands.

S is an elongation of the perpendicular tube which enters the chimney; it is intended as a receptacle for the water that may be condensed in the upper part, and to prevent its penetrating into the interior of the stove. The cover that terminates this elongation facilitates the cleansing the pipe without taking it to pieces.

The dotted lines forming the square space Q show the place where a niche or oven which actually exists in some of the Swedish stoves, may be fixed, and which advantageously varies the masonry-work that would otherwise fill that space.

All these figures being drawn on the same scale, the proportions may be easily preserved throughout.

The

The construction of this stove is neither difficult nor expensive.

The external surface may be coated with china tiles similar to those used in common stoves, that is to say, thin in the middle, and with a rim all round; which renders them more firm. They may also be fixed by a plate of metal in form of a girt. The back may be plain brick. The vase which stands on a slab of marble, or stone, is only an ornament.

In case heating apertures should not be wanted, the whole internal part may be built of bricks, of a convenient shape, cemented with diluted potters earth, and laid on their broad surface *(de champ)* for the circulating-flues, without any other iron-work than a cast-iron plate over the fire-place, the door, and its frame.

The additional expense attending the heating-apertures consists merely of the four cast-iron plates, with their tongues and grooves to form the compartments represented in Fig. 7. All the rest is made of iron rolled and nailed; which being once bedded in brick-work can never suffer the air to escape.

These iron-plates with grooves have been well known since the adoption of Dr. Franklin's stove, and there is an engraving of them in his works; but if there be any difficulty in procuring them, the deficiency may be supplied in two ways;

1st. By ends of cast-iron pipes placed vertically beside each other, thus serving as sides to the fire-place, and communicating with each other by small channels above and below, constructed in the brick-work.

2d. By common smooth cast-iron plates soft enough to be pierced with a drill, in order to affix with

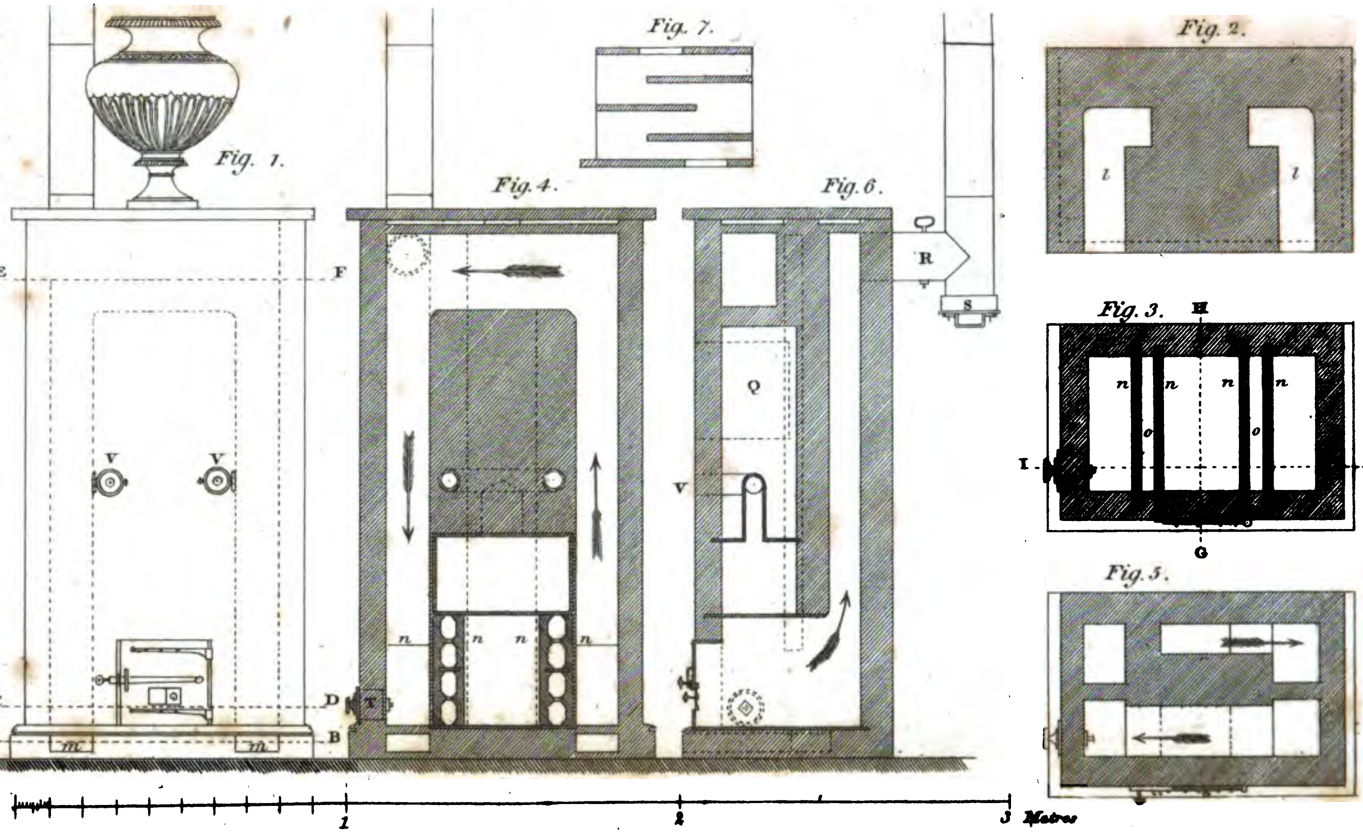


Fig. 1.
E
F
V
V
C
D
A
B
m
m
Fig. 4.
n
n
n
n
T
Fig. 7.
Fig. 6.
Q
V
R
S
Fig. 2.
l
l
Fig. 3.
H
n
n
n
n
o
o
I
K
G
Fig. 5.
1
2
3 Metres

with riveted nails wrought iron-plates bent into ſquares throughout their length, which are a complete ſubſtitute for the tongues and channels in caſt-iron, and as they are never expoſed to the flame, there is no danger of their failing.

It may eaſily be perceived that this laſt method is the moſt advantageous, becauſe it occupies leſs ſpace, and yet offers a larger ſurface to receive the heat and communicate it to the air.

Before I conclude, I ought to declare the good effects I have experienced from a ſtove of theſe proportions during the ſpace of two years.

It ſtands in an apartment that looks to the Northward, whoſe ſuperficies is 47 ſquare metres (about $12\frac{1}{3}$ fathoms), and its height 42.5 decimetres (13 feet).

The wood burnt daily at one time is a billet 28 a 30 centimetres in circumference (10 a 11 inches) ſawed into 3, or the equivalent in wood of ſmaller ſize. The door of the fire-place is then cloſed, and as ſoon as the wood is converted into charcoal, the key R in Fig. 6 is turned. Ten hours afterwards a heat above the mean temperature is felt throughout the apartment, and the centigrade thermometer (that of 100 degrees) placed 36 centimetres (above 13 inches French) from the ſides of the ſtove, riſes rapidly to 16 or 17 degrees.

The better to ſhow how far the ſaving of fuel and the retention of heat may be carried by this contrivance, I will further relate an experiment I have repeated under various circumſtances, and which has always afforded nearly the ſame reſults.

The thermometer being between 9 and 10 degrees in this apartment (there had been no fire the day before), the uſual quantity of wood was put into the fire-place about 11 o'clock in the morn-

ing,

ing, and at 3 in the afternoon the same quantity of fuel was added.

At 4 o'clock the thermometer placed at the above-mentioned distance was at 42 degrees.

At 5 o'clock	at	37°.
7	——	34°.
9	——	31°.
12 midnight		26°.

The hand could not yet bear the heat of the metal round the heating apertures, and the ball of the thermometer being placed opposite one of these apertures at a distance of 8 centimetres (about 3 inches), it rose in 4 minutes to 35 degrees.

The next morning at 9 o'clock the thermometer, which had been replaced at the distance of 35 centimetres, was at 22 degrees.

Lastly at noon or 21 hours after the last quantity of wood had been added, and 18 after the key R had been turned in consequence of the whole having been converted into charcoal, the thermometer stood at between 18 and 19 degrees. It was then held at the distance of two centimetres only from the heating apertures, when in less than 6 minutes it rose to 26 degrees.

These effects are so different from those commonly obtained by consuming three or four times as much wood, that I must expect some of my readers will believe I am exaggerating; but I hope so many will be induced to make the trial, that their example and testimony will at length triumph over our old customs and produce a general conviction, that without suffering any privation ourselves, we may preserve to our posterity that important necessary of life, of which a useless prodigality is daily robbing them.

LXI.

LXI. *List of Patents for Inventions, &c.*

(Continued from Page 288.)

ROBERT DICKINSON, of Long Acre, St. Martin's-in-the-Fields, Middlesex; for a method of fixing the straps of and to saddles, to which the girths are usually made fast.
Dated February 6, 1802.

JOHN SOUTHEY Lord SOMERVILLE; for a double furrowed plough fit and proper for ploughing of land in this kingdom.
Dated February 6, 1802.

CHARLES MERCIE, of the city of Bath, Music-master; for slides, which he calls air-slides, to be fixed to windows, doors, and partitions of all descriptions, for preventing the external air from entering rooms, carriages, &c.
Dated February 6, 1802.

HENRY PENNECK and ROBERT DUNKIN, of the town of Penzance, Cornwall, Gentleman; for methods for improving the sailing and navigating of certain ships and vessels.
Dated February 19, 1802.

JOSEPH NELSON, of Leeds, Yorkshire, Clothier; for a method of making or manufacturing woollen cloth. Dated February 19, 1802.

BRYAN HIGGINS, of the parish of St. Anne, Soho, Middlesex, Doctor in Physic; for an apparatus for heating air equally to any requisite degree, and methods of applying the air so heated with peculiar advantage, efficacy, and economy of the fuel, to the numerous purposes for which stoves

ſtoves and kilns have heretofore been employed.
Dated February 19, 1802.

George Holland, of the Pariſh of St. Andrew, Holborn, Middleſex, Hoſier; for a machine to be added to the ſtocking-frame, for the purpoſe of improving the manufacture, and expediting the manufacturing of fleecy hoſiery, and various other kinds of hoſiery.
Dated February 23, 1802.

George Bodley, of Exeter, Devonſhire, Ironfounder; for a portable ſtove or kitchen for the purpoſe of dreſſing victuals.
Dated February 27, 1802.

George Hodson, of the city of Cheſter, Aſh-manufacturer; for a method of preparing or manufacturing foſſil or mineral alkali from various ſubſtances. Dated February 27, 1802.

Richard Pottinger, of the pariſh of Ealing, Middleſex, Engineer; for an apparatus whereby perſons riding in carriages may on occaſions, and in circumſtances of imminent danger, liberate themſelves, and eſcape impending miſchief, by freeing the horſe or horſes inſtantly from the carriage. Dated February 27, 1802.

John Lewis, of Lamb's-buildings, in the pariſh of St. Luke, Old-ſtreet, Middleſex, Manufacturer; for a method of preventing accidents by a horſe or horſes drawing a carriage or carriages. Dated February 27, 1802.

Printed by Nichols and Son, Red-Lion-Paſſage, Fleet-Street.

REPERTORY
OF
ARTS AND MANUFACTURES.
NUMBER XCVI.

Printed by NICHOLS and SON, Red-Lion-Passage, Fleet-Street.

LXII. *Specification of the Patent granted to Mr.* THOMAS WINTER, *of Shacklewell, in the County of Middlesex, Gentleman; for a certain Manufacture for covering the Floors of Rooms, also for covering and packing Goods and Merchandizes, and fit to be used for various other Purposes of the like Kind.* Dated June 2, 1801.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said letters patent, and the proviso or condition therein contained, I the said Thomas Winter do by this instrument, under my hand and seal, particularly describe and ascertain the nature of the said invention, and the manner in which the same is to be performed; which are as follows:

First. I procure from the tanners yards the waste tan or bark, after it has been used for the purposes of tanning. This I cause to be well washed, and freed from dirt, and the fibrous parts picked and separated from those which are more brittle. The tan or bark so prepared I cause to be boiled for a considerable time until the fibres are so softened as readily to separate, and be

LXIII. *Specification of the Patent granted to Messrs.* JAMES *and* JOHN ROBERTON, *of Tradestown, Glasgow, Engineers; for a Method of applying Steam in the working of Steam-Engines, by which a very great saving of that Article is effected, and a proportional saving of Fuel in raising and applying Steam for the Use of Steam-Engines; and a Method of constructing Furnaces for the Application of Fire to Steam-Engine-Boilers, and Boilers of various Descriptions; and also for the Application of Fire to many other Purposes and Branches of Manufacture where Heat is applied, by Means of a Furnace; by which Invention and Improvement a very considerable saving of Fuel is effected, from the immediate Conversion of the whole, or very near the whole, of the Smoke arising from the Fuel into Flame.* Dated August 13, 1800.

WITH A PLATE.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said John Roberton, in compliance with, and in performance of, the aforesaid proviso, in the said in part recited letters patent contained, do, by this present instrument in writing, under my hand and seal, particularly describe and ascertain the nature of the said inventions in the said letters patent mentioned, and how the same is to be performed, and declare the same to be in manner following; that is to say: Whereas in the best constructed steam-engines there is a considerable quantity of steam which escapes past the sides of the piston in time of working, and is lost without producing

any

any mechanical effect whatever; so the principle of the said invention of a new and improved method of applying steam in the working of steam-engines; by which a very great saving of that article is effected, and a proportional saving of fuel in raising and applying steam for the use of steam-engines, consists in preventing so great a quantity of steam from escaping, and in making the steam, which actually does escape, act on another piston, and add to the power of the engine. In all forms of the engine after specified and described in the drawings hereto prefixed, to which reference is had, it is to be observed, that there are two steam-cylinders, with pistons fitted to each, the one cylinder of a lesser, and the other of a larger size: these act together in producing the effect. To these cylinders are annexed a condensing vessel and air-pump, as in many others, or varied in this, as circumstances or inclination require. The other parts of this engine, in its various forms, are either pointed out, or correspond with many engines in use, which are well known, and require no explanation. But the ground on which the patentees claim of preference is founded in the mode of conducting the steam on and between the pistons, as formerly mentioned, and more fully explained in the practical description of the engine.

Fig. 1. (Plate XVI.) First form differs little in construction from many other engines, except that in place of one working cylinder in these there are two, in this, (see Fig. 1,) the lesser (*n*) being placed on the top of the larger (*m*), and made fast to it. To each cylinder there is a piston fitted, which are connected together by a cylinder D; or this cylinder is so made as to have the pistons in one piece

piece with it. This cylinder is made ſo that it may nearly fill the ſmall cylinder *n*; that is, that it may work up and down ſo that the external ſurface of the one may not rub on the internal ſurface of the other. The ſteam and conducting pipes, with the valves, are explained in the following deſcription of the operation of the engine.

Let the working handles, with the valves, be placed in ſuch a manner that ſteam from the boiler may have free acceſs through the pipes and cylinders into the condenſing veſſel, to free the whole of the air, as in the uſual manner. When this is done, the engine is ſet to work by the valves *b* and *c* being ſhut, and by that of *a* left open, and water let into the condenſing veſſel C, when a vacuum takes place in it by means of the condenſation of the ſteam, and alſo in the under part of the large cylinder *m*, below its piſton, (there being a communication from it to the condenſing veſſel by the pipe F): ſame time the ſteam from the boiler has free acceſs through the pipe A, and valve *a*, into the ſmall cylinder *n*, above its piſton *h*, and exerts its force upon it, and preſſes it downwards with as much force as in the uſual manner. But as it is found, from experience, that a conſiderable quantity of ſteam eſcapes paſt the piſton, this ſteam is in part detained by the ſecondary piſton *g*, and exerts its force on that part or annular ſection *s s* that is contained betwixt the cylinder *m* and D, and aſſiſts in forcing the whole downwards; while at the ſame time the ſteam which is lodged in this annular ſpace *s s*, and around the cylinder D, prevents ſo great a quantity from eſcaping paſt the firſt piſton as would otherwiſe be the caſe were

there

there no ſecondary piſton, and the vacuum much more complete below the firſt piſton, conſequently there is a greater power produced from a ſmaller quantity of ſteam than with a ſingle piſton. During the time of the piſton's deſcent the ſteam valve *a* is ſhut, and the elaſticity of the ſteam within the cylinders carries the piſtons forward to near the bottom of their cylinders, when the valves *b* and *c* are opened by the handles and plug-work admitting the ſteam to paſs from the upper ſides of both piſtons through the pipes B and E to the condenſing veſſel C, while the counter weight at the other end of the beam, or this connected with a fly-wheel, raiſes the piſtons again when the valves *b* and *c* are ſhut, and that of *a* opened by the plug-work, when the engine makes another ſtroke as before. The piſton rod R joins the working-beam in any of the uſual modes, and in other reſpects the engine is much the ſame as in common practice; to this form of the engine, a conſiderable improvement takes place by means of another valve, and which conſtitutes the ſecond form of the engine (ſee Fig. 2); the form differs little from the laſt; but in admitting the ſteam from the upper cylinder below the piſton of the larger, and aſſiſting the returning ſtroke, and conſequently producing a ſtill greater effect from the ſame quantity of ſteam than in the firſt form, it may be underſtood from the following deſcription of the operation of the engine in this ſtate: let the working-handles be placed ſo that ſteam from the boiler may have free acceſs through the pipes and cylinders into the condenſing veſſel, to free them of air as in the uſual manner; when this is done, the engine is ſet for working by the valves *b* and *c* being ſhut, and *a* and *d* left open,

open, and water let into the condensing vessel C; when a vacuum takes place by means of the condensation of the steam, and also in the under part of the larger cylinder *m* below its position *g* (there being a communication betwixt them through the valve *d* and pipe F), and the steam from the boiler having free access through the pipe A, the valve *a* will exert its force on the piston *b* of the small cylinder, pressing it downwards with as much power as in the usual manner, but as a quantity of steam escapes the piston, it produces the same effect as mentioned in the first form; during the time of the piston's descent, the steam valve *a* is shut, and the elasticity of the steam within the cylinders carries the pistons forward to near the bottom of the cylinders, when the valve *d*, which admits the steam from the lower part of the large cylinder *m* to the condensing vessel, is shut, while the valves *b* and *c* are opened; by this means the steam which remains above the piston *b*, in the small cylinder, having free access through the pipe BB to the bottom of the large cylinder *m*, below its position *g*, exerts its force equally on equal areas as of each piston; and the annular ring, or section *s s*, being exhausted by the valve *c* being open; this admits the steam to pass through it, and the pipe E, to the condensing vessel C; this steam therefore which remains above the small piston, and below the large piston, will force the pistons upwards in proportion to the steam's density, and the difference of the areas of the piston, that is, a force in proportion to the density of the steam, and the excess of the area of the large piston to that of the small one, when the pistons arrive at the top of the cylinders, the plug-tree turns the handles of their

their poſition for another ſtroke, &c. It would be needleſs to deſcribe any more of the practical part of the engine, as it may be ſeen from inſpection of the draught, and correſponds with many of thoſe in common uſe, and which are well known. In this ſtate of the engine, there are three circumſtances take place, which renders the engine more powerful with the ſame quantity of ſteam than thoſe with a ſingle piſton; the firſt is, the ſteam which eſcapes the firſt piſton acts on the annular ring of the ſecond piſton, and increaſes the power; the ſecond is, the ſteam which eſcapes and is detained in the annular ſpace, or ſection *ss*, acts againſt the ſteam which paſſes the firſt piſton, and prevents ſo great a quantity from eſcaping as would take place were there no ſecondary piſtons; the third is, the quantity of ſteam which remains in the upper cylinder being let into the lower, and aſſiſting the aſcent of the piſton. In this and the firſt form, it is neceſſary to have a ſmall pipe with a cock in it, ſo connected with the upper part of each cylinder, that a little ſteam may be made to paſs through it by opening the cock a little when the piſtons are newly packed, and ſo admitting a ſmall quantity of ſteam to act upon the ſecondary piſton at this time, when little eſcapes the firſt, and when the friction of the piſtons is greateſt.

Third form of the engine (ſee Fig. 3) conſiſts of two cylinders, a larger and ſmaller, placed along-ſide of each other vertically, and which may be placed ſo that a line joining their centres may be either in the direction of the working-beam, or at right angles to it, the operations being the ſame in both caſes, but the laſt is preferable; the other parts of the engine are obvious, from the

 drawing

drawing and the following explanation. T
ſteam is admitted from the boiler by the pipe
and all the valves being kept open, and the wh
cleared of air, as mentioned in the former caſes t
valves *b d* and *e* are ſhut, while thoſe of *a c* a
f are left open, and water let into the condenſi
veſſel C, and a vacuum takes place, as alſo in t
large cylinder *m* below its piſton (there bein
communication to the condenſing veſſel C throu
the valve *f* and the pipe F), and there bein
communication from the bottom of the ſm
cylinder *n* to the top of the large cylinder
(through the pipe B and valve *c*), the ſteam in t
cylinder *n*, below its piſton, the ſteam in the pi
B, and that which is above the piſton *g* of t
large cylinders *m*, will exert their force in puſhi
the piſton forward, and reſiſting the deſcent of t
ſmall piſton *h*; but the ſuperior ſtrength of t
ſteam, from the boiler exerting its power on t
top of the piſton *h* of the ſmall cylinder, w
cauſe it to deſcend; as the piſtons go forward
their reſpective cylinders, the ſtrength of t
ſteam above the piſton *g* of the large cylinde
and under the piſton *h* of the ſmall cylinder, w
diminiſh, but the ſuperior ſtrength of the ſtea
above the piſton *h* of the ſmall cylinder wi
cauſe a quantity of the ſteam to paſs it, whic
will in part exert its force on the piſton *g* of t
large cylinder, and aſſiſt in forcing it down in t
cylinder; indeed, what ſteam remains betwixt t
two piſtons exerts equal forces on equal areas
each piſton, but the piſton of the large cylinde
being of greater area than that of the ſmall cy
linder, will be forced down with a power as muc
greater, (as it retards the piſton of the ſmall cy
linder,) as its area is greater than the other. Durin
th

the deſcent of both piſtons (which move in the ſame direction in the ſame time) the valve *a* is ſhut, which admits the ſteam into the ſmall cylinder, and the elaſticity of the ſteam which remains above the piſton *b* of the ſmall cylinder, together with the leſs denſe ſteam betwixt the piſtons, carries both piſtons forward to near the bottom of the cylinders, when the returning ſtroke begins by the valves *b d* and *e* being opened, and the valves *c* and *f* ſhut (the valve *a* being ſhut during the deſcent of the piſtons). By ſuch means, the ſteam above the piſton *b* of the ſmall cylinder has free acceſs below it, through the valve b and pipe B, alſo to the underſide of the large piſton through the valve *e*. In this ſtate, the ſteam is equally ſtrong on the top and bottom of the piſton *b* of the ſmall cylinder; but the ſteam below the piſton *g* of the large cylinder exerting its force againſt it whilſt there is a vacuum made in the upper ſide of the cylinder above the piſton, (the ſteam having free acceſs through the valve *d* and pipe E F to the condenſing veſſel), this piſton will therefore be forced upwards, and as the two piſtons are faſtened by their rods to the beam in ſuch a manner as to move together, they will both aſcend together to near the top of their cylinders, when the plug-tree turns their handles and valves for another ſtroke. The valves *a c* and *f* being opened, and thoſe of *b d* and *e* ſhut, and the ſteam from the boiler exerting its force on the piſton *b* of the ſmall cylinder, while the ſteam which remained at the laſt ſtroke below the ſaid piſton, and of leſs denſity, together with what paſſes the piſton *b*, exerts its force on the bottom of the piſton *b* of the ſmall cylinder, and on the top of the piſton *g* of the large cylinder, and the

 work

work goes on as aforesaid. In this form of the engine, there are three circumstances take place which render it more powerful, with the same quantity of steam, than those with a single piston; the first is, the steam which is lodged between the pistons, together with what passes the first piston, acts on the second piston with a power much greater, as it retards the first, as the second piston is longer in area than the first; the second is, the steam, which remained above the piston of the small cylinder, after its descent, acts upon the piston of the large cylinder, in the time of its ascent; and the third is, what steam remains in the small cylinder, after its ascent, contributes, along with the steam which escapes the piston of the small cylinder, to prevent so great an escape of steam past it, as would otherwise be the case, were there no secondary pistons; the other parts of the engine may be seen from inspection of the draught, and correspond with what is in common use.

Fourth form of the engine (see Fig. 4) consists of two cylinders, a lesser and a larger, the piston rods of which are connected by a toothed wheel, or short beam placed betwixt them, which gives motion to the machinery by a crank, or otherwise; by this method, the piston of the one cylinder ascends, while the other descends; the operation of the steam in these cylinders and pistons is directly the same as the last, only the pistons move contrary to one another, the steam being directed on the pistons so as to produce this motion, though the acting principle is directly the same; the same description as the last will fully explain it, and the same letters of reference serve, only, that the steam acts on the top of the

the piston of the large cylinders in the same way as it acts on the bottom of it in the former case. These cases may still be varied by placing the small cylinder in the first case undermost, and admitting the steam from below, and in the two last cases by admitting the steam into the small cylinder below; but the principle, or mode of action, will still be the same: indeed, the same principle may be varied many ways, but, perhaps, in none better than the following:

Fifth form (See Fig. 5, No. 1 and No. 2) consists also of two cylinders, as before, and larger, which are placed alongside of each other, as in the third form. Fig. 5, No. 1, is a side view or section of the engine; but the large cylinder, which stands immediately behind the small one, is not seen as well as many of its parts. In Fig. 5, No. 2, is an upright section of the cylinders and pipes, as the face, the framing or body of the engine. In this draught, the cylinders, pipes and valves, and condensing vessel, are laid open in so plain a manner, that, with the explanation, an idea of the engine may very easily be conceived; the letters of reference are chiefly applicable to No. 2; but when the letters are placed on No. 1, they refer to the same as on No. 2. The operation and explanation are as follows: the steam is admitted from the boiler into the small cylinder *n*, through the pipes A A, and valves *a* and *e*, both above and below the piston *h*, of the small cylinder, all the valves being kept open, and the handles wrought in the usual manner, to drive the air out of the cylinders, communicating pipes, and the condensing vessel; the handles are set to their due working posture, that is, the valves, *b*, *c*, and *e*, are shut, while those of *a*, *d*, and *f*, are

are opened, and water let into the condenſing veſſel, when a vacuum takes place in the large cylinder *m*, below its piſton *g* (the ſteam having free acceſs through the valve *f*, and pipe F, to the condenſing veſſel), and the ſteam which remains above the ſaid piſton, together with that which is under the piſton *b* of the ſmall cylinder, and communicating pipe D, exerts its force in puſhing down the piſton *g* of the large cylinder, there being a communication for the ſteam between them, through the valve *d* and pipe D. The ſteam from the boiler exerts its force on the top of the piſton *b* of the ſmall cylinder, and, as the piſtons move forwards in their cylinders, the denſity of the ſteam under the piſton *b*, and above the piſton *g*, will diminiſh, being expanded to a larger ſpace; but the ſuperior denſity of the ſteam from the boiler, acting on the top of the piſton *b*, of the ſmall cylinder, will cauſe a quantity of ſteam to paſs it; which exerts its force in part on the piſton *g*, of the large cylinder; indeed, what ſteam is lodged between the two piſtons exerts equal forces on equal areas of each piſton, but the piſton *g*, being of larger area than the piſton *b*, will therefore be forced down with a power as much greater as it retards the piſton in the ſmall cylinder, as the area of the large piſton is greater than that of the leſſer; at the ſame time the ſteam which remained beneath the piſton of the ſmall cylinder, prevents ſo much ſteam from eſcaping paſt its ſides, as it would do were there only a ſingle piſton, and the vacuum below it much more complete during the deſcent of the piſtons (which move in the ſame direction, in the ſame time); the valve *a*, which admits the ſteam from the boiler, from the top of the leſſer cylinder,

der, above its piſton, is ſhut, and the elaſticity of the ſteam which remains above the piſton *b* of the ſmall cylinder, together with the leſs denſe ſteam above the piſton *g* of the large cylinder, carries both piſtons forward to near the bottom of their reſpective cylinders, when the returning ſtroke begins by the valves *a* and *f* being ſhut (the valve *a* being ſhut during the piſtons deſcent), and the valves *b c* and *e*, opened by the plug-work. When the large cylinder is exhauſted above its piſton, the ſteam having free acceſs through the pipes D and E, and the valve *e*, to the condenſing veſſel, while the ſteam from the boiler having free acceſs through the pipes A A, and valve *e*, to the bottom of the piſton *b*, of the ſmall cylinder, and the ſteam of leſs denſity, from the laſt ſtroke of the engine, which remains above the ſaid piſton, together with what eſcapes paſt its ſides, in time of its aſcent, having free acceſs through the valve *b* and pipe B to the under ſide of the large cylinder *m*, and below its piſton *g*, and exerts its force in preſſing it upwards, with a power as much greater as it retards the piſton of the other, as the piſton of the large cylinder is greater than the other; then the piſton *b*, of the ſmall cylinder, will be preſſed up with a force in proportion to the difference of the denſity of the ſteam above and below it; at the ſame time, the ſteam which remains above the piſton prevents ſo much of it from eſcaping paſt the ſmall piſton, as would be the caſe were the vacuum more complete; during the aſcent of the piſtons, the valve *c* is ſhut, and the elaſticity of the ſteam which remains below the piſton *b*, of the ſmall cylinder, carries it forward, as doth alſo the leſs denſe ſteam of the piſton *g* of the large cylinder; indeed, the operation

operation of the ſteam is the ſame, both in the aſcent and deſcent of the piſtons.

Sixth form (ſee Fig. 6) conſiſts alſo of two cylinders, the leſſer and larger, the piſton-rods of which are, as in the fourth form, connected by a toothed wheel, or ſhort beam placed betwixt them, which gives motion to the machinery by a crank; or otherwiſe the operation of the ſteam in this form is directly the ſame as in the laſt, or fifth form, except that the ſteam is ſo conducted as to make the one piſton aſcend while the other deſcends; the explanation of the laſt ſerves this alſo, and letters of reference are placed ſo, only where the top or bottom of the large piſton is mentioned; the contrary muſt be underſtood for the explanation of this form; in all forms of the engine in time of working, the denſity of the ſteam, on the ſecondary piſton, is never allowed to be near its natural ſtate (namely, that denſity it hath at coming from the boiler, or nearly the ſame with that of the atmoſphère), the other end intended would be in a great meaſure fruſtrated, as the quantity which eſcaped the ſecondary piſton in that ſtate would be attended with as bad effect as that propoſed to be remedied by the patentees. It will be obſerved, that this is effected by ſhutting the valve which admits the ſteam from the boiler before the piſton has moved through the whole length of the cylinder; though the preventing the waſte of ſteam is the main thing intended, yet the conſtruction of the engine is ſuch, that the elaſticity of the ſteam is carried a great length, and uſefully employed, before it gets into the condenſing veſſel; theſe forms of the engine may be applied either to the raiſing of water, or driving machinery, the ſame as thoſe in common uſe.

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The patentees do not pretend to fix upon any exact ratio betwixt the size of the two cylinders: experience and motives of œconomy may cause a variation in this.

Specification and description of the nature of a new and improved method of constructing furnaces, for the application of fire to steam-engines and boilers of various descriptions, and also to the application of fire to many other purposes and branches of manufacture where heat is applied by means of a furnace, by which invention and improvement, a very considerable saving of fuel is effected from the immediate conversion of the whole, or very nearly the whole, of the smoke arising from the fuel into flame: first, the said invention in principle consists in supplying the burning fuel more fully with air, having this fuel more in a body together, and a less quantity in combustion, at the same time, than what usually takes place in other furnaces, which are applied to the same uses; in applying the fuel with a portion of fresh air, admitted from an opening made for that purpose, and directed in such a manner as it may come in contact with the smoke from the kindling coal and great heat of the furnace together, and the fuel being more fully supplied with air, and consequently a greater degree of heat taking place, and the smoke and fresh air uniting in the great heat, the smoke is enflamed, and rendered useful in adding to the heat of the furnace; besides, this portion of fresh air is so conducted as to act partly on the kindling or kindled fuel, and raising it to a greater degree of heat, after it has served its purpose by uniting with and enflaming the smoke; and therefore is employed, in some measure, usefully, even after the coal has ceased to smoke: secondly,

to the above may be added, the form of the furnace, which is so constructed, that the full kindled fuel is kept backward in the furnace, while the fresh coal lies before, and is more gradually kindled than if introduced further among the full kindled fuel, while the heat of the furnace is little injured or damped by the introduction of fresh coal, as is more fully described in the practical description of the furnace. The coal is admitted into the furnace by a hopper, feeder, or mouth-piece, A (Fig. 7 and 8), made of cast iron (but which may be made of other materials), and inclined to the horizon, as in Fig. 7; so that the coal in it may, in some measure, fall into the fire-place, above the bars, as the fuel is spent; in the upper part of this hopper, feeder, or mouth-piece, is a Plate, *a* (Fig. 7 and 8), placed at a small distance, or from about three-eights to three-fourths of an inch from the upper side of the hopper, betwixt which plate, and upper plate, or side of the hopper, a stream of air rushes downward on the fire, at about half a right-angle to the horizon, which stream of air assists in consuming the smoke, as formerly mentioned, and more fully described hereafter. B, Fig. 7, is a section of the bars, which are, in general, a little inclined to the horizon, as in the figure, that the fuel may more easily fall, or be pushed backwards, in the furnace; at *c*, is an opening above the bars, and below the lower end of the hopper, which is in general fitted with a grated door or doors, which open for the more convenient cleansing of the furnace, and the grated form of the doors is also designed for admitting air into the fuel, as well as at the bars, consequently the air is more concentrated in the middle of the burning fuel,

fuel, and produces a greater heat than if admitted only betwixt the bars; this grated form of the doors is alſo convenient for the admiſſion of a poker or inſtrument for puſhing backward the kindled fuel, while the freſh coal, or that which is not ſo well kindled, falls down to ſupply its place; in ſome others of theſe furnaces, the opening below the lower end of the hopper, and above the fore end of the bars, is left without doors at all; at this opening, it is convenient, when the fire is mended, to puſh the coal from the fore ſide backward, as mentioned above, or it may be puſhed backward with a hooked poker, P, by applying the hooked part of it through the furnace bars below; by either of which means, the kindled coals are put backwards, while the freſh coal, or that which is not ſo well kindled, falls down to ſupply their place; that is, the coals, in the ſituation *c*, are puſhed towards *d*, while thoſe in the ſituation *f* fall down to ſupply the place of thoſe which were driven from *c* towards *d*; by ſuch means, the ſtrength or heat of the fire is not much damped by the introduction of freſh coal, and the coals which have fallen from *f* towards *c*, are not ſo rapidly kindled as if introduced above the burning fuel, ſame time the ſmoke which ariſes from theſe newly-introduced coals, paſſes partly through the full-kindled coal and partly over, and in contact with the great heat of the burning fuel, and, meeting at the ſame time with the current of freſh air coming downwards, and tending alſo to drive the ſmoke ſtill nearer to the bright kindled fuel, does in general completely inflame the ſmoke, and render it uſeful in adding to the heat of the furnace. Another end obtained by the ſtream of freſh air, is to keep in ſome

meaſure the great heat of the furnace from acting ſo violently on that part of the hopper which is neareſt it, and moſtly expoſed to its heat, and liable to be damaged thereby, which it does by the continual current of freſh cool air that is in contact with thoſe parts; the conſtruction of the furnace may be much varied, but the chief improvements are, that the fuel in combuſtion is ſupplied with air by the foreſide as well as by the bars, the hopper is placed in ſuch a ſituation that the kindled or unkindled coal may in part fall to the foreſide of the furnace above the bars, as the other fuel is puſhed backward in the furnace, and the admiſſion of freſh air to paſs over the burning fuel by means of a definite ſpace or ſpaces, opening or openings, made for that purpoſe; ſo that this ſtream, current, or currents of air, partly come in contact with the burning fuel itſelf, forcing alſo the ſmoke with more immediate union with the burning fuel and great heat of the furnace. The Patentees do not pretend any claim to the admiſſion of freſh air as a new principle, as they are ſenſible that this has been known long ago, and practiſed by admitting it at the furnace door, ſhutter, or mouth-piece, and at the opening the coals are admitted into the furnace; their claim reſts upon what has been formerly ſtated, together with the form of the furnace, and its variations after-mentioned; the ſucceſs of the furnace depends alſo upon a conſiderable degree on what is called the draught of the furnace; that is, the chimney and flues ſo conſtructed, as a ſufficient current of air may paſs through the fire to bring it to a proper degree of heat; alſo, that the current of freſh air may have ſuch force as to come pretty much in contact with the burning

ing fuel, and to convey the ſmoke along with it through the hotteſt of the flame; if this is not the caſe, the ſmoke will not be ſo completely conſumed in theſe furnaces. The hopper is allowed to be kept as full of coal as poſſible, and either wholly or in part ſmall coal, ſo as to prevent air as much as poſſible getting in by that paſſage; this muſt be attended to when the furnace is in its ordinary working ſtate; yet, ſometimes, it is neceſſary to keep this opening of the hopper, either wholly, or in part, open, when there is little heat wanted.

Description and Reference to the Draughts. (See Plate XVI.)

Fig. 7, is a ſide view, or ſection of the furnace, as if applied to a boiler, and cut through the middle. Fig. 8, is a front view of the furnace in perſpective, the hopper having a diviſion in the middle, and two regulating plates for the admiſſion of freſh air. Figs. 7 and 8, A, the hopper into which the coals are put to ſupply the furnace, *a* the regulating plate; above which and below, the higher plate *b* of the hopper, a ſtream of freſh air is admitted to this plate; *a* is made to turn on a pin pivot or centre, ſo that it may be brought nearer to, or recede further from the uppermoſt at the point *n*, Fig. 7, for regulating the quantity of air admitted betwixt the plate as occaſion requires; this plate is ſometimes made faſt, or kept ſo, after adopting a ſpace which is judged ſufficient for the quantity of freſh air, but on other occaſions, as in ſteam engines, it is adviſeable to give it leſs or more opening according to the ſtate of the fire, that is, when coals are newly introduced into the fire-place, to give the greateſt quantity of freſh air, and when they are pretty well

well kindled to give lefs air. FFF, Fig. 7, the flues beneath and round the boiler; that round the boiler may be in any of the prefent well-conftructed forms; that beneath the boiler, as in the drawing with a breaft D, to prevent the coal getting fo far backward in the furnace, and alfo to direct the flame on the bottom of the boiler: this breaft is alfo neceffary for the more complete combuftion of the fmoke, as by that means, the frefh air, fmoke, and flame are more completely combined than if the breaft were wanting, or ill-formed; at *r* is reprefented a fhutter, which is fometimes ufed in fteam engine boilers for the purpofe of getting the refufe of the fuel taken from the furnace by opening the faid fhutter; in other cafes, the breaft of the furnace D coincides with *d* at the ends of the bars. G, Figs. 7 and 8, the grated-doors, or opening into the fire-place; I, the afh-pit below the furnace; L, Fig. 8, a catch, or bar, which flides along the bottom plate of the hopper for keeping the grated-doors fhut: HHH, &c. the brick-work for furnace and boiler. K, Fig. 7, a piece of caft-iron in a horizontal pofition, which joins the under plate of the hopper, for the more eafe and convenience in putting in the coals, the hopper may be made in one or more pieces, as inclination or choice may direct, or of any materials which it may be thought prudent to adopt, but they are ufually made with five plates of caft-iron; M reprefenting one of the fide plates, N the uppermoft, O the undermoft, and P the regulating-plate; the fide plates having tenons which fit into mortices in the top and bottom plate, which may eafily be conceived; on the fide plates are detents or abutments, which ferve as a centre for the regulating-plate to turn

upon;

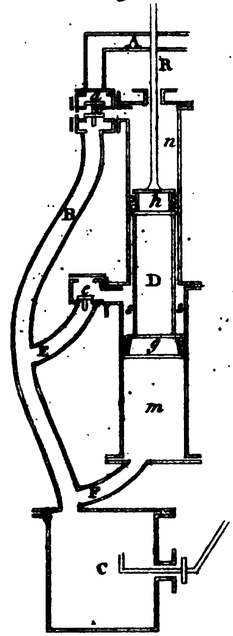
upon; on this plate are alſo two abutments which reſt on the other abutments of the ſide plates when this plate is put into its place; this plate by ſuch means may be taken out, or put in at any time it is found neceſſary, without meddling with any other part of the hopper: another method is to have the bottom plate to come out, and in the ſame manner as the regulating plate; alſo, that it may fold up or down to any inclination; this form is very commodious for allowing acceſs into the fire-place to get it repaired, or the like, or for having the fire quickly taken from it altogether, for by folding the plate to a level as repreſented by the dotted line, Fig. 9, the coal which is in the hopper is prevented from falling into the fire-place, and there is a greater ſpace left to get into it; this form may either admit or not of the grated-doors; indeed the ſimple opening does very well. Fig. 9, is a repreſentation of the ſide of the hopper, in this form: another method of the hopper, and letting in of air, is by making the underſide of the top plate with cheeks, or grooves, as that the freſh air may ruſh down in them above the fuel that lies in the hopper, for when the hopper is fitted in as cloſe with coal as it can be, theſe grooves of cheeks prevent the coal from getting into them, and from ſeparate and definite ſpaces for the air to ruſh down on the burning fuel, and perform the ſame office as the regulating plate, though the proper quantity cannot be ſo well adjuſted this way, yet the only way to accompliſh this is to have theſe grooves or cheeks made as near the proper ſize as poſſible; they ought alſo to be ſo narrow, that little of the coal will get betwixt them. Fig. 10, is a front view of the hopper, in the ſtate where A repre-

ſents

ſents the opening the coals are put into; another method is to let in the current of freſh air above the uppermoſt plate of the hopper, this may be done either by another plate placed above, or the building ſo formed over it, as that a proper quantity of freſh air may get in, and in a proper direction; indeed, this may be accompliſhed many ways in a greater or leſſer degree, by letting in a definite quantity, directed in ſuch a manner as to come in contact with the fuel, though perhaps in no way better than the methods explained; to make this furnace more complete, doors are placed to the front, with a ſufficient ſpace below them to let air into the furnace, theſe doors are repreſented by S S, Fig. 8, as ſtanding open; they are kept ſhut while the furnace is going, except when coals are put in, or the bars cleanſed, or the like when they are opened for that purpoſe; the uſe of theſe doors is to prevent, in a great meaſure, the radient heat that comes from under the bars and from the opening at the foreſide from eſcaping; this alſo adds ſomething to the draught or well-going of the furnace, as this heat when ſuffered to eſcape rarifies the air before the furnace, which air paſſes upwards, performing in a ſmall degree that which a chimney does, and depriving the fire of a portion of air which it otherwiſe has when the doors are ſhut; theſe furnaces are made of various ſizes, according to the uſes they are applied to; in ſome large ones there is a diviſion in the middle of the hopper, as in Fig. 8; this ſize, as meaſured by the ſcale, will ſerve a ſteam-engine boiler of about nine or ten feet diameter; leſſer furnaces do not need this diviſion in the middle of the hopper. In witneſs whereof, &c.

LXIV.

Fig 1.



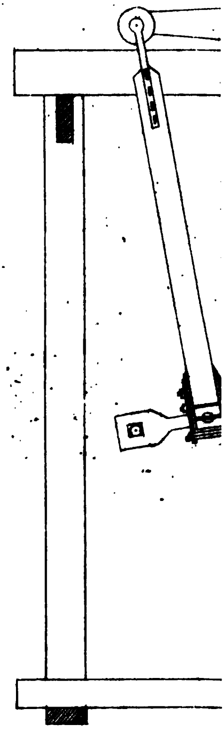
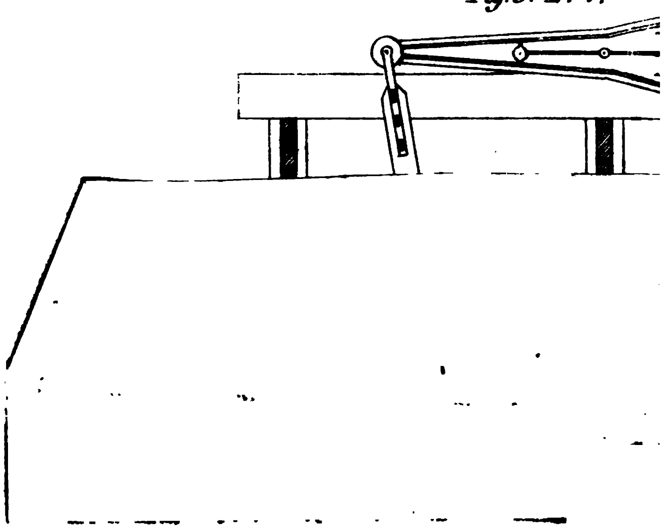


Fig. 5. No 1.



LXIV. *Specification of the Patent granted to Mr.* Thomas Howard, *of Manchester, in the County of Lancaster, Soap-boiler; for a Method of making a British Barilla and Potash, and of obtaining a greater Quantity of Alkali than hitherto discovered.* Dated June 2, 1801.

THE following is the ſpecification* of a patent, dated the ſecond day of June, 1801, for an improved method of making a Britiſh barilla and potaſh, and of obtaining a greater quantity of alkali than hitherto diſcovered, by ſaturating with quick lime the aſhes made from bleachers waſte lie, rock ſalt, ſoda, natron, common ſalt, black aſhes of the ſoap-boilers lie, kelp, or tobacco aſhes, ſal enixum, caput mortuums of the vitriolic and muriatic acid; and alſo for ſeparating the vitriolic and muriatic acids as they exiſt in common ſalt, ſea water, bleachers waſte lie, and the lie or ſalt of ſoap-boilers waſte lie; theſe, or any or all of them together, or any other ſubſtance, that whole or in part contains a vegetable mineral or foſſil alkali.

To obtain the alkali contained in aſhes made from the bleachers waſte lie, rock ſalt, common ſalt, ſoda, natron, black aſhes of the ſoap-boilers waſte lie, kelp, or tobacco aſhes, I take of the rock ſalt, common ſalt, black aſhes from the ſoap-boilers waſte lie, kelp, or tobacco aſhes, or any or all of them, twenty hundred weight; or of

* The form uſually adopted in the preamble to Specifications appears in this inſtance (the only one we have noticed) to have been omitted.

ashes made from bleachers waste lie, soda, or natron, or any or all of them, ten hundred weight; and grind, pound, or roll them sufficiently fine, as to pass through a fine sieve. To which I add sixteen hundred weight of cokes or cinders, charcoal, smallcoal, dyers waste wood, sawyers dust, or any other combustible, destitute of sulphur, being first ground and sifted. These I mix till they appear of one sameness, and then spread on an even floor a thin layer of them: to which I add a layer of quick lime, on which I sprinkle as much common water, lie, brine, or sea water, as the mass will absorb. This done, I continue the layers until sixteen hundred weight of lime is added: I let them here saturate, and whilst warm I cut down the layers, and add a sufficient quantity of common water, lie, brine, or sea water, as when ground, beat, or trodden with the feet, or any other mode, it assumes the appearance of mortar, which, when done, and perfectly dried, either upon iron plates or pans, or any other more convenient way, introduce it into the reverberating furnace, and bring the same into a flux, at a moderate temperature, which in two, three, or four hours, or more, (according to quantity,) being repeatedly stirred, and the same temperature kept up, will produce what I call my British barilla.

To obtain the alkali contained in sal enixum and caput mortuums of vitriolic and muriatic acids, I take, if of sal enixum or residuum of muriatic acid, twenty hundred weight, and if of vitriolic acid, thirty-five hundred weight; to each of which quantities separately, or a due proportion of them jointly, I add of natron ten hundred weight

weight of black aſhes of the ſoap-boilers waſte lie, fifteen hundred weight of kelp, twenty hundred weight of ſalts obtained from the ſoap-boilers waſte lie, twenty hundred weight, or any other, neutral ſalt or alkali in proportion to its quality; to which I add thirty-two hundred weight of cokes or cinders, charcoal, or ſmallcoal, ſawyers duſt, or dyers waſte wood, or any other combuſtible ſubſtance deſtitute of ſulphur. The above ground, ſifted and well mixed, to be ſpread on an even floor, as before, until thirty-two hundred weight of quick lime be added, and then proceed as before, which will alſo produce my Britiſh barilla.

To obtain the ſeparation of the vitriolic and muriatic acids as they exiſt in common ſalt, brine, or ſea-water, the bleachers' waſte lie, and the ſoap-boilers waſte lie, or the ſalts obtained therefrom, I take of ſalts obtained from the ſoap-boilers waſte lie twenty hundred weight, or of common ſalt twenty hundred weight, and ten hundred weight of tobacco aſhes. Theſe, either ſeparately or jointly, in the above proportions; to which, if ſalts obtained from ſoap-boilers waſte lie is uſed, add ſixteen hundred weight, and if common ſalt and tobacco aſhes twenty-eight hundred weight, (or a due proportion, according to the ſalts uſed,) of cokes or cinders, charcoal, &c. as before, to be ground, ſifted, and mixed, as before. Theſe ſpread in layers, and ſprinkled with lie, brine, or ſea water, until, if ſoap-boilers ſalts are uſed, ſixteen hundred weight of quick lime is uſed; and if common ſalt and tobacco aſhes, then twenty-eight hundred weight of quick-lime is uſed, or in that proportion, and then to

 undergo

undergo the aforementioned processes for making the British barilla.

If to make potashes, I add to every twenty hundred weight of the whole mass twenty hundred weight of black ashes, salts obtained from soap-boilers waste lie, or any other neutral salt or alkali, in due proportion, which I treat in the manner before mentioned with the aforesaid mass, or I introduce it in like proportion at the time of charging the reverberating furnace. But I prefer the former; in two, three, or four hours, from the introduction, (according to the quantity,) it will become a liquid mass, which I then tap, and call my British potash.

Notwithstanding the proportions above prescribed, the writer is aware that great diversity of opinion upon the proportions of each ingredient will be found amongst the consumers; first, on account of the alkali basis, and secondly, with regard to the causticity desired; but the writer is of opinion, that the proportions he has laid down are preferable to any other. Notwithstanding which he desires it may be understood, that every process to obtain alkali from any of the before-mentioned ingredients, by saturating with quick lime in any proportion, and treading or grinding as before described, will be an infringement of this patent.

LXV.

LXV. *Specification of the Patent granted to Mr.* ARNOLD WILDE *and Mr.* JOSEPH RIDGE, *of Little Sheffield, in the County of York, Saw-makers; for making and manufacturing all Kinds of Saws, Steel Doctors for Printers, Plates made of Iron, also of Steel, Beads, Mouldings, and Fender Plates, made of Iron and Steel united, or of Iron or Steel, and all Sorts of Springs made of Steel, and of divers other Articles made of Iron and Steel united, and also of Iron or Steel.*

Dated August 25, 1796.

TO all to whom these presents shall come, &c. NOW KNOW YE therefore, that we the said Arnold Wilde and Joseph Ridge do hereby declare, that our said invention of making and manufacturing all kinds of saws, steel doctors for printers, plates made of iron, also of steel, beads, mouldings, and fender plates made of iron and steel united, or of iron or steel, and all sorts of springs made of steel, and divers other articles made of iron and steel united, and also of iron or steel, is particularly described and ascertained in manner following; that is to say: When the steel or iron is pared or cut into proper shape, the saws, doctors for printers, plates of iron or steel, beads, mouldings, and fender plates, whether made of iron and steel united, or of iron or steel, and all sorts of springs made of steel, and divers other articles made of iron and steel united, and also of iron or steel, are put into a frame of metal, or otherwise: they may then be made red-hot in the said frame, and stretched by screw spring weight, or any other proper power or purchase, and so formed into a curved, straight, or any other direction wanted.

They

They are then to be immerſed in water, or a compoſition of oils or greaſe, to be hardened in the frame in the direction wanted; and when ſo hardened they are alſo to be tempered in the ſame direction in the frame over fire; and when the ſaw, doctor for printers, or plate, is over the fire, it muſt be kept in motion over the fire until the oil or greaſe upon the ſaid ſaw, doctor, or plate, ſmokes. It is then to be gently ſtretched, and continually kept moving over the fire until a blue blaze alternately appears and diſappears. It is then to be ſtretched with as much power as will bring it into the direction required. The ſaw, doctor, or plate, is next to be put into another frame, which may be made to move upwards and downwards, or in any other direction neceſſary, by crank, or any other movement, between proper ſtones, or between plates of metal, blocks of wood, or any other material that will grind or poliſh with ſand, emery, or other proper material to grind and poliſh the ſaws, ſteel doctors for printers, plates made of iron, alſo of ſteel, beads, mouldings, and fender plates, made of iron and ſteel united, or of iron or ſteel, and all ſorts of ſprings made of ſteel, and divers other articles made of iron and ſteel united, and alſo of iron or ſteel. But if the ſaw, doctor, or plate, is not intended to be hardened, it muſt be made red-hot, and ſtretched with as much power as will bring it into the direction wanted; it muſt then lie in the open air, in the frame, in the ſaid direction required, till cold; then to be ground by a machine for the purpoſe of grinding and poliſhing in a frame the ſaid ſaws, ſteel doctors for printers, plates made of iron, alſo of ſteel, beads, mouldings, and fender plates, made of iron

iron and ſteel united, or of iron or ſteel, and all ſorts of ſprings made of ſteel, and divers other articles made of iron and ſteel united, and alſo of iron or ſteel. Which machine is to move the ſaid ſaw, doctor, or plate, by means of a crank, or otherwiſe, as before expreſſed; and which motion will pare, tooth, ſmith, finiſh, ſet the teeth of ſaws, ſharpen, grind, and poliſh, plates made of iron or ſteel, or of iron and ſteel united, and form beads and mouldings, and various other articles. In witneſs whereof, &c.

LXVI. *Method of harvesting Corn in wet Weather. By Mr.* JOHN PALMER, *of Maxſtock, near Coleſhill, Warwickſhire.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal was adjudged to Mr. PALMER *for this Communication.*

THE weather proving extremely rainy, and my corn then ſtanding, taking much damage, I determined upon cutting it wet, and thraſhing it immediately, and then drying it on a kiln: in conſequence of this, I collected as many men as were ſufficient for the purpoſe, and employed them as follows, *viz.*

I cauſed a part of my men to cut the corn in the common method with ſickles, and bind it into ſheaves.

ſheaves. A ſecond part I employed to load it on waggons, and carry it to the barn; and as many as could work in the barn, to thraſh it. The next morning I winnowed it, and carried it to a malt-kiln to be dried; which operation was always completed in leſs than twenty-four hours.

As it is impoſſible for me to ſend you two ſheaves of the corn harveſted as above deſcribed, I have ſent you the produce of two ſheaves and upwards, which I declare to be a fair ſample of the produce of four acres and upwards.

A timber-ſtove, or a hop-kiln, will anſwer the purpoſe of drying corn equally well as a malt-kiln.

The Expence per *Acre was as under ſtated.*

	£.	s.	d.
Reaping and carrying to the barn, –	0	12	0
Thraſhing and winnowing, – – –	0	12	0
Kiln drying, – – – – – – – – – –	0	5	0
	£. 1	9	0

N. B. Only a part of the above ſum ſhould be charged to my new method of harveſting corn, *viz.* the extra expence, which is as follows:

Five ſhillings *per* acre for drying, and four ſhillings for the extra trouble of thraſhing it.

After the wheat above mentioned was thraſhed in the common method with flails, and dried, I ſo far completed a machine for thraſhing, that I thraſhed a very conſiderable quantity of wheat, and ten acres of barley with it, carried from the field in November; and it was dried in the manner deſcribed in my claim. I did not however ſtate

ſtate this to the Society, becauſe I had taken out a patent, dated the 6th day of December, 1799, for my thraſhing-machine; and was that day going to London to give in my ſpecification, dated the 4th of January 1800.

Part of the ſtraw of the four acres, deſcribed in my claim, was uſed for thatch immediately after it was thraſhed; and part ſtacked in ſmall narrow ridges, for litter for my fold-yarn.

The grain was very well ſeparated from the ſtraw by the flails; but that thraſhed by the machine was completely cleared, though in a very wet ſtate. This would not be the caſe with the common machines of the North.

The quantity of wheat upon an acre was about twenty-one buſhels, which is nearly as much as there would have been if it had been dried by fine weather. When the advantage of getting in an acre of wheat *per* day, in ſeaſons like the laſt, is properly conſidered, and making it immediately uſeful, at the ſmall additional expence of nine ſhillings *per* acre, there can be but little doubt reſpecting its utility; for probably theſe men could not be employed at any other work.

The above letter was accompanied with three certificates; one from Mr. Edward Palmer, of Maxſtock, in the county of Warwick; another from the Rev. John Dilke, of Maxſtock-Caſtle: and the third from Mr. William Twamley, of Sutton Colfield, in the county of Warwick, miller: which teſtify that Mr. John Palmer did harveſt four acres of wheat and upwards in the year 1799; that his plan is likely to be of general advantage; and that his thraſhing-machine is in high repute, and anſwers every end propoſed.

LXVII. *Experiments on the tanning Principle, and Reflections on the Art of Tanning.* By M. MERAT GUILLOT.

FROM THE *ANNALES DE CHIMIE.*

THE length of the procefs defcribed by M. Prouft * to obtain tan, induced me to make fome experiments, and to feek a more expeditious method of procuring it: the following are the refults:

1. I infufed bark, reduced to a fine powder, in water; I let it ftand feveral days, filtered the infufion, and treated it with lime-water; I obtained a precipitate in confiderable quantity, which I collected on a filter, dried it, and afterwards applied alcohol, to afcertain whether it was foluble in this menftruum; but the alcohol was not even tinged by it.

2. Being defirous of difcovering if the lime poffeffed a greater affinity to acids than to the tan with which it was combined, I treated four grammes of the precipitate mentioned above with nitric acid diluted with water; with the affiftance of a very gentle heat, a moderate effervefcence was produced, with a feparation of carbonic acid; after twenty-four hours infufion, I filtered the liquor, which had affumed a very deep colour, and there remained on the filter a granulated, black, fhining fubftance, having a four and rather bitter tafte; this refiduum weighed fomething lefs than two grammes.

* See our eleventh volume, page 59.

3. To

3. To ascertain whether the nitric acid had dissolved the lime, I treated the liquid which I had filtered with acidulated oxalate of potash, and obtained an abundant precipitate, which made me conjecture that since the nitric acid had dissolved the lime, the substance which I had obtained on the filter must be tan, since the precipitate obtained by the mixture of the lime-water and infusion of bark was produced by the union of the tanning principle and lime: to convince myself of this, I treated one portion with water, and the other with alcohol; I let the infusion of these substances stand on a sand-bath twenty-four hours, the water was deeply coloured, and the alcohol still more; but all the tan (hitherto I only supposed it such) was not dissolved; the alcohol dissolved rather more than half, and the water less. I treated these two liquids, after having filtered them, with a dissolution of paste, and obtained a precipitate resembling that produced by a mixture of the infusion of bark with the same solution, but of a deeper colour, and rather less elastic. When treated with the nitrate of tin, I obtained a precipitate that became gelatinous: when treated with lime-water, the tan united with the lime, and reproduced the tanate of lime formed before.

Could I suppose that with these properties it was not the pure tan? No, because it gives the same results as that obtained by M. Proust's process.

If purer tan be required than that obtained by the dissolution of the lime of the tanate of this substance by an acid, the infusion of alcohol must be evaporated, and tan of the purest quality will be left.

Muriatic acid produced the ſame effects as nitric acid.

The expedition with which the upper leathers of ſhoes are tanned, by the proceſs of M. Seguin, who, in manufacturing them, merely ſubjects them to the preparations of waſhing and finiſhing with lime water, without afterwards ſwelling them, and then tans them, cauſed me to ſuppoſe that in this caſe a combination is formed between the tan and the lime contained in the ſkin thus finiſhed, independent of the combination of the tan with the gelatinous ſubſtance contained in the ſkin, which accelerates the fabrication. May it not hence be preſumed, that the fabrication of theſe leathers would be accelerated if, after having waſhed them and finiſhed them with lime-water, they were to be ſwelled in *juſée*, or water in which old bark, which has been once uſed for tanning, is infuſed. Under this circumſtance the ſmall quantity of tan diſſolved in this water would combine with the lime with which the ſkin would be charged in the finiſhing, and would form a tanate of lime. The ſwelling would probably take place by this method with leſs celerity than by the ſulphuric acid; but it would perhaps be preferable, as the ſkin in ſwelling would begin to be charged with tan, whilſt, by the ſulphuric acid, the lime with which the ſkin is impregnated after having been finiſhed with this ſubſtance diſſolved in water—the lime, I ſay, combines with the ſulphuric acid employed to make it ſwell, which I preſume muſt give leather a brittle quality that it would perhaps not have by this method. Perhaps, likewiſe, after having ſwelled the ſkins in the infuſion of old bark, their fabrication

fabrication might be accelerated by putting them at first into an infusion of bark, according to the method of M. Seguin, and afterwards dipping them alternately in lime-water and the infusion of bark, always taking care to leave them but a short time in the lime-water, which might perhaps alter them, if they were suffered to remain in it too long. Under this circumstance the lime-water with which the leather would be charged would, when the latter is put into an infusion of bark, produce a more speedy precipitation of the tan, and its union with the lime, as well as with the gelatinous substance contained in the leather. I think, likewise, that by this method leather would acquire a greater weight, a quality aimed at by tanners, and would perhaps become less permeable to water.

These conjectures I have ventured to advance, because they appear to be suggested by the theory of the art of tanning. Perhaps in this instance, as in many others, practice will not accord with theory. I leave it to artists to try this method, which I myself shall not fail to do when a favourable opportunity presents itself.

LXVIII. *Observations on dying with Madder, followed by a simple and invariable Process for obtaining, in its greatest beauty and solidity, the Colour known by the appellation of Levant or Adrianople Red.* By JEAN MICHEL HAUSSMAN.

(Concluded from Page 343.)

I HAVE endeavoured, in various trials, to exhaust the madder by simple ebullition, and without any other addition than that of chalk; but it always appeared to me to be attended with injury to all the colours excepting black; I thought that even the effect of the madder was far superior when the heat was managed with moderation, and that accumulated heat easily decomposed the colouring substance. This tendency to decomposition, and particularly by fermentation, if ever so little damped or diluted with water, has hitherto prevented my obtaining from it a substantial colour, sufficiently deep and solid to be applied to any stuff whatever. I have moreover observed, that too great a degree of heat in the first instance, when the dye is intended to be used a second and third time, not only prevented my obtaining lively and agreeable tints, but also the requisite strength. The aqueous vehicle of the madder, at too a high a temperature never fails to weaken the power of adhesion of alum and oxid of iron to stuffs, and to take away a portion of them, which, upon examining the bath, is easily discovered by persons accustomed to the business.

I repeat, that, for common articles and of little value, it is indispensably necessary to use gall-

nuts

nuts or ſumach, in order to ſave one-half, or even two-thirds of the madder; but the colours thus obtained are leſs brilliant and leſs ſolid. The addition of chalk muſt nevertheleſs not be forgot; without it the gallic acid would carry away a portion of the alum and coloured oxid of iron, the loſs of which would weaken and tarniſh the tints; it would likewiſe injure the white that might have been preſerved in the ſtuffs. Without adding gall-nuts or ſumach, I conſider it impoſſible totally to exhauſt the madder of its colouring particles, whence I preſume that their adheſion is promoted by the viſcid nature of the tanning principle of thoſe aſtringent ſubſtances, which carries away the colouring particles by its combination with them. I muſt farther obſerve, that gall-nuts, as well as ſumach, loſe the quality of ſtaining black, and on the contrary acquire the property of ſtaining or colouring alum yellow, and oxid of iron a green olive, with the addition of chalk, whoſe calcareous baſis unites with the gallic acid. Are theſe yellow and olive green colours produced by any particular ſubſtance contained in the gall-nuts and ſumach, or do they originate in the tanning principle? This queſtion remains to be examined.

The quantity of madder to be uſed in dying ought not only to be proportionate to the extent of ſurface to be dyed, but alſo to the concentration of the liquors of *acetite of alum and iron*, improperly denominated mordants: that is to ſay, to the greater or leſs quantity of alum or oxid of iron which theſe ſaline liquors, either ſeparate or combined, may have left or depoſited by the evaporation of the acetic acid, when drying upon the articles to be coloured. If the articles to be

dyed

dyed are not very numerous, or particularly if most of them are to exhibit only vivid tints, the madder may be applied but once; but the application of madder may be repeated twice and even thrice, when the articles are numerous and are intended to present deeper tints. Three-quarters of a pound of madder of a good quality are sufficient for dying a piece of callico of a white ground, six ells in length (three-quarters wide), and which is to contain but few coloured objects: the quantity of this colouring substance will increase in proportion to the mass of alum or oxid of iron, expended on a piece of stuff of the same dimensions: it may be augmented to 6, 8, 10, and even 12 pounds for well covered grounds, of a brilliant colour, and of the utmost deepness. Attention and experience in the management of a dying establishment will not fail to point out, with sufficient accuracy, the proper proportions.

Whatever care may have been taken with the madder, to prevent the adhesion of dusky particles, it requires much more, that the colours obtained may possess all the beauty and solidity they can possibly acquire in the finishing, preceded by a very long ebullition in perfectly clear water. This ebullition alone may be made to answer the purposes of finishing by the addition of bran; the reds will assume a more lively hue by using soap, with or without the addition of bran; carbonate of potash or soda substituted for soap will extract the tints from crimson; but I must observe, that to prevent the danger of turning the reds into brown, and in such a manner as never to be able to recover them, they must, by all means, previous to the application of soap or alkali, be exposed to the action of the most violent

violent heat that can be given to water; the success of this operation will be the more complete by giving very little vent to the aqueous vapours, and by forming, as it were, a digester with the cauldrons employed. The solidity of the colours will be proportionate to the time they have been exposed to the action of the boiling water. It is needless to mention, that the same risk is not incurred of injuring the colours by soap and alkaline carbonates, when the madder, instead of being kept at a moderate heat, has been made to boil, as is customary in many dye-houses; but in this case the colours obtained are more difficult to be finished.

As water charged with oxygenated muriatic acid destroys the colouring particles of madder, and also of other vegetable and animal substances by decomposing them, and afterwards more concentrated acids can, in their turn, clear away from the surface of stuffs the colourless alum and oxid of iron, I cannot possibly countenance the idea of a chemical combination of colouring particles with alum and metallic oxids, which, being fixed and coloured upon any stuff whatever, make in my opinion only compound aggregates.

The finishing of impressions with objects in white, requires modifications, which I shall detail at another opportunity, as soon as I shall find leisure: it will therefore now be sufficient to state, that, after having for some time prosecuted the experiments inserted in the Annales de Chimie of the year 1792, I discovered a red infinitely more beautiful and solid than the Levant, by fixing alum on cotton yarn or on thread by an alkaline solution of that earth mixed with

linseed oil. The following is the process I employed.

After having made a caustic lye, with one part of good potash of the shops, dissolved in four parts of boiling water and half a part of quicklime, which I afterwards killed, I dissolved one part of pulverised alum in two parts of boiling water, and whilst this solution of sulphate of alum was still quite hot, I, with all possible expedition, to prevent the recrystallization, kept pouring into it, and stirring at the same time without intermission, the above caustic lye, till the alum it had at first precipitated after the saturation of the sulphuric acid was redissolved. I afterwards suffered this solution of alum to stand; it exhaled ammoniac, and as it cooled formed a precipitate of sulphate of potash in very small crystals; after which I mixed with it a 33d part of linseed oil, with which the alkaline solution of alum forms a kind of milk. As the oil by degrees separates from this mixture under the appearance of cream, it ought to be stirred again before it is used; the skains of cotton or thread should successively be dipped in it, pressed equally, and hung to dry on a line in the order in which they were taken out of the mixture: they must be dried under cover from the rain in summer, and in a warmed place in winter, and remain 24 hours; they should then be washed in clear running water, and again dried; then dipped in the alkaline lye, squeezed and dried a second time, in the same manner as before; taking care, however, to recommence the immersion in the lye with those skains which came last out of the oily composition, because the first invariably take away a greater portion of the oil than the latter; it will be advisable

visable also to use the whole of the mixture at once, that it may not have time to attract the carbonic acid with which the lower region of the atmosphere, particularly of work-shops, is always charged; for the alkali in returning to the state of carbonic suffers the alum to precipitate, and loses the property of commixing with oil.

Two impregnations of the alkaline solution of alum, mixed with linseed oil, are sufficient to obtain a fine red; but, by continuing to impregnate the skains a third and even a fourth time under the same circumstances as the first, colours of the utmost brilliancy will be obtained.

The deepness of the red intended to be obtained will be proportionate to the quantity of madder employed in dying; by taking the same weight of madder as that of the skains, it will produce a red which the finishing will turn to a roseate tint; on the contrary, you will obtain a more or less lively carmine by using two, three, and even four parts of madder, never forgetting the addition of chalk, if the water employed contain none; four parts of this colouring substance will produce a red of such beauty and brilliancy, that it could never be brought into circulation in commerce, on account of its high price. By diluting the alkaline solution of oily alum with two or three parts of water, and impregnating the skains twice, thrice, and even four times in the manner mentioned above, bright tints will be produced without using much madder; but they will not be so deep as those procured by means of the same solution concentrated, and as small a quantity of madder.

The best manner of procuring clear and lively tints at the same time would be to expose, for a sufficient length of time, deep and finished reds,

to the action of the lye of oxygenated muriate of potash or of soda, with the addition of alkaline carbonate to procure such a degree of colour as might be required; but it may easily be conceived that this method would be the most expensive.

To have the alkaline solution of oily alum always as nearly as possible in the same state of concentration, it will be necessary to use an aerometer, to determine the degree of strength of the caustic lye, before it is employed in the process of the solution of alum. This caustic lye may, at first, be made of the best potash that can be procured in the shops, and the degree it may give to the aerometer should be noticed, that, if afterwards one were obliged to use potash of inferior quality, one might by evaporation bring the lye obtained therefrom to the degree fixed.

The caustic lye, made with four parts of good potash of the shops*, cannot contain much extraneous salt. In making a great quantity, and after having poured off the limpid part, it will be necessary to shake the vessel twice every day for some time, in order to be able to pour off the rest of the alkaline liquor; and, that no part of what remains in the vessel may be lost, it should be diluted with fresh water, which may afterwards be used for dipping the cotton, which, before it is subjected to the dye, should be purified and cleaned; which may be done by lye, soap, or simply boiling it in water, and afterwards rinsing and drying it. As squeezing with the hands might derange the filaments of the skains of cotton

* I have not the least doubt, but that, in cases of necessity, soda might be substituted for potash.

yarn

yarn and thread, and consequently weaken the thread, it will be advisable, in operations on a large scale, to squeeze them by means of a press.

As to the thread, intended to be dyed a deep, beautiful, and solid red, it should be previously well bleached and impregnated at least four times successively with the alkaline solution of oily alum; not only because alum and metallic oxids adhere less readily to thread than to cotton, but likewise because these mineral substances, after being coloured, more easily quit thread than cotton in the finishing. It still remains to be examined, whether, between each impregnation of the alkaline solution of oily alum, the cotton yarn or thread requires to be left a longer or shorter time before being rinsed and dried.

All gross oils may be used for this mixture with proper precaution, but linseed oil mixes best, and remains longest suspended in the alkaline solution of alum; but I never tried fish oil; perhaps it might be preferable. Perhaps, likewise, in processes on a large scale, it might be advisable to diminish the quantity of linseed oil in the mixture with the alkaline solution of alum; for I have frequently had occasion to observe that too much oil was injurious to the attraction of the colouring parts of the madder: a 33d part of linseed oil always produced the best effect in my experiments on a small scale.

As to the process of dying thread or cotton yarn, sufficiently charged with alum by the oily alkaline solution of that earth, the skains must first be cleared from every saline substance, and likewise from superfluous oil, by rinsing them for a considerable time in clear running water; after

this

this they must be arranged, without drying, in a machine that it will be necessary for every one to adapt to the form of the cauldron wherein it is to be placed, so that during the operation of dying the skains may be continually moved and turned about, in order to imbibe equally and throughout the colouring particles. The bath must be composed of madder mixed with a sixth part of pulverized chalk diluted with about 30 or 40 parts of water. The heat must not be carried beyond such a point that a person might hold his hand in the bath, for an hour, without scalding, and it should be kept at that degree two hours longer, either by taking away the fire, if the furnace preserve sufficient heat, or by supplying it with a little fuel from time to time. Three hours dying are sufficient to exhaust the madder; upon leaving the bath, the skains should be washed in plenty of water to clear them; they must then be submitted to the action of the finishing, which consists in boiling them a long time in water containing a quantity of bran tied in a bag, and adding thereto soap and alkaline carbonate, to give the red a roseate or crimson hue.

As I never had occasion to dye cotton yarn or thread on a large scale, I performed the process in a small copper, which served me at the same time for finishing: with regard to the last operation, I confined myself to boiling the skains, after well arranging them in water, containing a small bag full of bran, for eight hours successively; and, in order not to interrupt the ebullition, I replaced the part evaporated with fresh boiling water. In this finishing I used neither soap nor alkali, and, notwithstanding, I obtained a red surpassing in beauty

beauty and solidity that of the Levant, and capable in every respect of standing a comparison with the best dyes of France, or Paul Remy and Son's, of Lausanne.

For dying my red, I used three parts of the best madder to one part in weight of the dry cotton yarn.

With the precaution I took to obtain an equal colour, I could dye at once; but I would advise this operation to be always performed at twice, taking, each time, half the quantity of madder and chalk, if one cannot continually keep turning the skains in the cauldron; it may likewise serve for finishing, by adapting to it a cover, leaving but a confined passage for the vapours, which one should endeavour to condense as much as possible, because it would be expensive to replace the evaporated part with fresh boiling water. Perhaps, in working upon a larger scale, and by concentrating the heat in cauldrons shut almost close, there might be no necessity to employ eight hours of ebullition to finish and give solidity to the colours. I have every reason to believe, that it was the finishing of Levant red that gave birth to the idea of bleaching with vapours: it might have been observed, that, in finishing, colours lose considerably in deepness; perhaps, at the same time, it may have been seen, that the pieces of pack-thread, used to arrange the skains, were bleached in finishing, and particularly by the addition of alkalis.

A very great variety of colours, and of different tints, may be procured by adhering to the same process as I have detailed for obtaining beautiful and solid reds. For this purpose, the alkaline

alkaline solution of oily alum must only be made use of, when such a tint of oxid of iron, or indigo blue, has been given as may be thought proper; but, whatever colour or tint may be intended to be given previous to fixing the alum on the skains of cotton, yarn, or of thread, these skains ought always to be first thoroughly boiled and cleansed; the power of adhesion of the sediment of indigo, as well as that of oxid of iron, and likewise of coloured alum, being augmented by the colouring particles of the madder, if they are submitted to the action of the heat of boiling water, before they are impregnated with the alkaline solution of oily alum. The manner of dying all kinds of blue tints with indigo being already well known, it is not worth while to detail it; and as to producing a yellow rust-colour, which is done with very little expence, it depends only on soaking the skains thoroughly in a solution of sulphate of iron, on pressing them equally, and immersing them afterwards in a caustic lye of potash, which will precipate and fix the oxid of iron of a disagreeable colour, but which will uniformly assume a yellow tint like rust, by attracting and saturating itself with the oxygen of the atmospheric air: this yellow will be more or less deep, in proportion to the greater or less quantity of sulphate of iron contained in the solution; one may likewise give more brilliancy, and even more equality to yellow rust-colour, by soaking the skains a second time in the ferruginous solution, and immersing them in the caustic lye. Care must be taken not to use soda for this operation, as it generally contains sulphur which turns black the oxid of iron by mineralizing it.

Skains,

Skains, coloured blue and yellow rust-colour, treated with the alkaline solution of oily alum, will procure, with the madder, purple colours, violet, lilack, &c. &c. It may easily be imagined, that if, instead of madder, the same skains prepared for dying with madder are coloured with kermes, cochineal, fernambuc, campeachy wood, Santa Martha wood, woad, yellow wood, Avignon nuts, &c. &c. a vast variety of tints will be obtained: these tints may even be multiplied to infinity by mixing the colouring ingredients of one, with the other, in various proportions. The affinity of adhesion of the colouring parts of all these ingredients, varies also in this particular, that the tints produced by a yellow or olive green dye, are changed or totally metamorphosed by a second tincture of madder, kermes, cochineal, or fernambuc; and will furnish orange tints, capuchin, carmelite, brass, &c. &c. As the previous preparation of the skains by the alkaline solution of oily alum, may be too expensive for some of these colours, the process which I detailed in the Annales de Chimie of the year 1792, page 250, 17, 18, and 19, may be substituted in its stead, which consists in treating the skains alternately with soap and sulphate of alum, whose excess of acid has been saturated, either with carbonate of alkali or of lime; this process is very expeditious; the skains may be prepared and dyed on the same day, particularly in summer, red, as well as any other colours, which, for the most part, may be subjected to ebullition; and the operation of finishing with bran, for a quarter of an hour, half an hour, and some even for a whole hour. It must still be ob-

 served,

ſerved, that it is only the colours of madder, whoſe baſes of alum and oxid of iron have been fixed upon ſtuffs; by means of an alkaline oily ſolution, that can acquire perfect ſolidity by the action of the heat of boiling water; and that the ſolidity is far inferior in all thoſe colours of madder whoſe earthy and ferruginous baſes have been transferred to the ſtuffs by acid diſſolvents.

Alum, plentifully fixed on cotton or linen ſtuff, by means of one of the moſt concentrated alkaline ſolutions, very readily attracts the colouring particles in dying with madder. The effect is not the ſame, if the ſame earth is transferred to it by means of the moſt concentrated acetic ſolution of alum; it is abſolutely impoſſible to complete dying at one ſingle time, even if one were to be ſo laviſh of madder as to take infinitely more than would be required to obtain a ſatisfactory reſult, from repeating the proceſs three or four times*. This ſingularity will give occaſion for new and intereſting experiments; my obſervations prove mean while, that dying with madder in general requires to be managed with the moſt ſcrupulous attention.

* The concentrated acetic ſolution of oxid of iron is attended with nearly the ſame difficulties.

LXIX.

LXIX. *On native and artificial Sulphurets of Iron.* (Martial Pyrites). *By* PROFESSOR PROUST.

FROM THE *JOURNAL DE PHYSIQUE.*

I HAVE already obferved, in a former memoir, that if the acids, which eafily diffolve artificial fulphuret, have not the fame effect on native fulphuret, this arifes from the excefs of fulphur in the latter, which art has not yet difcovered the means of combining with the former. Hitherto, indeed, I did not imagine the imperfect means we poffefs could imitate nature in the formation of pyrites; but chance has very recently removed the difficulty.

I heated a mixture of about 10 ounces of fulphur and iron filings, without regard to any particular proportion, in order to fupply my laboratory with that fulphuret; and judging, by the colour, that it might not be fufficiently charged with fulphur, I thought it requifite to add more. The crucible was confequently made almoft red-hot, but not enough to melt its contents, becaufe it is more convenient and ufeful to be obtained in powder. On attempting afterwards to diffolve it with an acid properly diluted, I was furprifed to find that it yielded no fulphurated hydrogen, although I varied the ftrength of the acid, and, as it were, felt my way by various effays. This unexpected circumftance was the ray of light that led me to imagine it poffible to form pyrites.

Since pyrites becomes foluble, as has been feen, only in proportion as it is deprived of the fulphur which is in excefs above the point of faturation, it appeared to me, that I ought firft to endeavour

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to reſtore to it all its qualities, by bringing it back by means of the ſame exceſs of ſulphur to its firſt ſtate. In this attempt I ſucceeded.

I mixed an indeterminate quantity of ſulphur with 400 grains of pyrites of ſoria, deprived of exceſs by diſtillation, and heated the mixture in a retort, by the ſide of another, containing alſo 400 grains of pyrites, but in a crude ſtate. The object of this latter was to ſerve as a thermometer to prevent heating the former too much; or, in other words, to prevent expoſing to ſuch exceſs of heat this additional portion of ſulphur, which a new attraction was to add to that which conſtitutes a firſt point of ſaturation with regard to the iron.

At a certain degree of heat, the ſuperabundance of the ſulphur was carried off by diſtillation; after which, the two retorts being ſtill continued an hour longer, at the ſame temperature, I could not perceive the leaſt ſulphureous vapour.

The pyrites that was regenerated came out in powder, which convinced me that it did not retain any ſuperabundant ſulphur above the point of ſaturation; otherwiſe, I ſhould have found it glued and moulded to the retort.

It had reſumed the greeniſh-yellow colour, which is that of the crude and pulveriſed pyrites, whereas, before, it was dark and blackiſh, like ſulphurated iron which yields hydrogen. Its weight was 504 grains, or, in other words, the diſtilled pyrites reſumed, during this operation, in the proportion of 26 pounds of ſulphur per quintal.

By referring to the former memoir, it may be ſeen, that the main produce of two diſtillations, each of 400 grains of pyrites, was 318 for the reſidue in the retort, and 78 for the ſulphur; to which

which must be added 3 or 4, for that carried off by the gas above-mentioned, which gives 79 ½ per quintal for the residue, and 20 ½ of sulphur. According to this proportion, 400 grains of this residue, or of distilled pyrites, ought only to have resumed 98 and a fraction of sulphur, whereas the result of our experiment is 104. This difference, which amounts only to 1 ½ per quintal, and which is but a trifling excess, arises from the inaccuracy of the experiment, as well as from the nature of pyrites, which is not an homogeneous combination; for, besides clay and sand, it often contains a little oxyd of iron, which may have given rise to the fixation of a somewhat larger quantity of sulphur than it had lost by distillation.

I afterwards examined the regenerated pyrites with a sulphuric acid of 10 degrees of Beaumé's aerometer, which is a good solvent of distilled pyrites, and obtained only a few ounces of sulphurated hydrogen. I afterwards heated the mixture, which yielded some little gas, after which the pyrites remained unaltered, and, having continued the ebullition a long time, it was impossible to saturate the acid.

With the muriatic acid I succeeded in forming a little gas; but its action soon ceased, and it was likewise impossible to make the acidity disappear. It was acid of 12 degrees of the aerometer, and the powder preserved its colour. The natural pyrites, treated in like manner, affords not the slightest indication of gas; but it must not be forgotten, that art cannot give these compounds that aggregative approximation or density which is one of the grand obstacles that attraction must surmount in solutions. Of this, Guyton and Fourcroy

Fourcroy have given very ſtriking inſtances in the reſiſtance they found to the ſolution of the native oxyds of iron and of tin.

Pyrites, as I have already ſaid, not being an homogeneous combination, it is evident, that it was not in any former reſults, that the diſcovery of the true proportions of ſulphur, which ours can attract, could be expected; and therefore I made the following experiments.

To be able to depend on the purity of the filings, it is needful to begin by heating them gently, and for a long time, in a glaſs retort; during which the operator is not a little ſurpriſed to perceive, that filings cleaned by the magnet, and kept in well-corked phials, yield a very ammoniacal water, and even muriate, if I did not miſtake the taſte of the liquor ſeparated from them.

A hundred parts of filings, heated to a dark red in a retort, and on which ſulphur is dropped, turn white, as even the ancient chemiſts obſerved; but do not become ſaturated. They are only found to have 20 or 30 of ſurcharge. The product is ground; then mixed with ſulphur; and, by a red heat, a reſult is obtained, weighing always 159; but which I think may be fixed at 160, on account of the heterogeneous qualities of the iron.

The product is iron ſulphurated to the firſt degree. It may be melted, and does even melt in the retort, if harpſichord wire is uſed, and the heat be kept up without alteration. Its colour is metallic, but of a dark hue, and remote from the gold colour of pyrites. In a word, it is the ſulphuret which is fit for the production of ſulphurated hydrogen gas.

To

To diſcover the exceſs which this ſulphuret is ſtill able to fix, provided it has not to contend with ſo high a temperature, I treated 200 grains of filings with the attentions above deſcribed, and obtained 318 grains of ſulphuret. Being taken from the retort, it was mixed with an additional portion of ſulphur, and heated by the ſide of another containing crude pyrites. The ſuperabundant ſulphur paſſed off during the diſtillation, and the retorts were continued during an hour at the ſame heat. The reſult of this operation was an artificial pyrites, weighing 378 grains. It came out in powder, which further convinced me; it retained no more ſulphnr, than was apportioned to it by its attraction.

Its colour was no longer blackiſh, but of a greeniſh-yellow hue. Being treated with the acids, it acted entirely in the ſame manner as regenerated pyrites; and, laſtly, it differs from the native pyrites only in the want of denſity, which the latter derives from a cryſtallization that only takes place in a humid medium.

Inferences.

From all this it reſults, that iron fixes 60 per quintal of ſulphur in a temperature conſiderably elevated. This proportion conſtitutes the minimum of *ſulphurated iron.*

With an inferior degree of heat it attracts half that quantity more, and forms the maximum of ſulphurated iron, or with 90 of ſulphur; but, if this latter combination be expoſed to the temperature which produced the former, it will be brought back to the minimum by depriving it of all

all the excess of sulphur above 60 per quintal of iron. That, sulphurated to the maximum, is no other than pyrites, and, excepting its density, partakes all its properties.

To employ super-sulphurated iron for the production of hydrogen, it suffices to heat it with half its weight of filings.

To employ pyrites for the same purpose, they must be treated in like manner, or they must be distilled, in order to deprive them of that portion of sulphur which constitutes the difference between sulphuret at the minimum, and that at the maximum.

The mineral kingdom has not yet presented us with iron sulphurated at its minimum. In the yellow coppery pyrites, which is a compound of two sulphurets, the iron is always at its maximum of saturation; nor can any thing but acids oxydate the excess of sulphur so as to attack these minerals.

I have shewn, in my former memoir, that the native sulphuret of copper was customarily found with an excess of sulphur of 14 or 15 *per cent.* It is very possible, this metal may, in its saturation, be governed by the same law as iron; which ought to be examined into; but this should be done with sulphurets that are pure; for, in those which are complicated, or in which sulphuret of copper is an integral part, I found it without excess of sulphur.

The ores of yellow copper, or the native union of the two sulphurets of copper, and of iron sulphurated to its maximum, give by distillation less sulphur than simple pyrites, because the sulphuret of copper, which forms a part of it, has no excess,

cess. The fine coppery pyrites of Avalar, in Biscay, gives by distillation only one twelfth of sulphur.

If these pyrites are dissolved with a portion of potash, the excess of sulphur unites therewith, and the sulphuret of iron is brought back to its minimum; and then diluted sulphuric acid may serve to analyse them. It dissolves all the sulphuret of iron, without touching that of copper, which in this case presents itself with the dark blue colour which constitutes one of its characteristics. By these means is discovered the proportion of the two sulphurets which compose this species of mineral. But, by ascertaining the quantity of copper contained in a coppery pyrites, that of the sulphuret of this metal, which constitutes a part thereof, is also always known, because, in nature as well as in art, the copper never takes up either more or less than 28 grains of sulphur per quintal.

Native Sulphuret of Manganese.

This sulphuret has, I believe, never yet been discovered by mineralogists; till I found it, some time since, in certain specimens of gold ore from Nagiag.

The matrix of the piece, which afforded me this sulphuret, is a carbonate of manganese, mixed with quartz, like that of sulphuret of tellure. It does not exhibit the metallic crystals of that metal, but a multitude of points, which appear in the microscope a heap of pyritous particles. This mineral, treated with diluted sulphuric acid, gives in great abundance a mixture of carbonic gas and sulphureous hydrogen. The former arises

from the decompofition of the carbonate, and the latter from that of the fulphuret.

It is extremely eafy to be convinced of the exiftence of this new fulphuret: firft, becaufe, of all that are known, no one is fo eafily decompofed, and with fo great an abnndance of gas; fecondly, becaufe the artificial fulphuret of manganefe yields, with equal celerity, the action of that acid; and thirdly, becaufe, in the diffolution, nothing elfe is difcovered than the oxyd of manganefe, and an atom or two of that of iron.

The fpecimen contained, befides, neither gold nor filver, neither tellure, nor lead, &c.

In the true ore of tellure, I found that the fulphurets of lead and of tellure were combined together, and that gold was found therein native, and by no means mineralifed.

I fhall add no further obfervations on the fpecies of fulphuret I have here defcribed, becaufe I have not yet afcertained, whether the manganefe is in a ftate of oxyd or of metal; if in oxyd, its fulphuret probably derives, from a very clofe union of parts, the power of eluding the activity of the atmofpheric oxygen; for the artificial fulphuret paffes very readily into a ftate of black oxyd mixed with fulphate.

On the Disoxydation of Iron.

Confidering the facility, or low temperature, at which feveral oxyds repafs into a metallic ftate, it cannot but appear probable, that thofe which refift our furnaces, would be eafily difoxydated, could we give them the requifite degree of heat.

That the oxyd of iron may no longer be included among thofe that cannot be reduced without the aid of charcoal, I cannot help preferving from oblivion an experiment, for the means of per-

performing which, I was indebted to the friendſhip of Naſt, the china manufacturer, then eſtabliſhed in the Fauxbourg St. Antoine.

The mouth of the oven, ſituated above the furnace, was ſupported by a bar about an inch thick; the oxydation of which had ſo nearly approached its centre, that, being no longer ſupported by more than an iron-wire a line thick, it fell and broke. I collected the fragments, and ſeparated the wire by a ſlight blow. This oxyd differs in no reſpect from that which comes from iron when forged.

I placed about eight ounces of it in a china crucible incloſed in one of the lower air-chambers. I was not ignorant that merely a nail dropped into a furnace would deſtroy a whole pile. The reſult was as follows: the crucible and air-chamber were pierced; the iron was reduced, well melted, and had formed for itſelf a bed in the bottom of the furnace; nor could Naſt and myſelf take it out with the aid of tools. It was not at all brittle. But was this iron melted by the mere intenſity of the fire, or did it attract to itſelf carbon, decompoſe the calcareous part of the paſte, &c.? The inveſtigation would be intereſting. I kept this iron a long time, but have now miſlaid it, not being aware, at that time, how intereſting its examination might become in regard to the theory of chemiſtry. It is deſirable the experiment ſhould be repeated.

ON WAX.

I believe I can announce that wax exiſts in green fæcula; I had already found it in that of opium. It is entirely formed, I conceive, in the farina. I ſhall one day treat it as fæcula.

LXX. *On the Solution of Copper in Ammoniac.* *By M.* Hildebrandt.

In the course of my Chemical Encyclopædia I have sometimes exclaimed against the assertions of certain chemists, which appeared doubtful, and contradict those of other philosophers. Among these I class the observation of Dr. Hahnemann, who pretends that ammoniac dissolves neither copper, nor oxyd of copper; but that the solution of them in ammoniac is always effected by the carbonic acid, and in proportion to its quantity.

Without intending to contradict that experienced chemist, to whom we are indebted for many instructive treatises, I have been compelled by my own observations to doubt that of which I am speaking, and to submit it to the following experiments, which the brevity of my work precluded me from there detailing at large; I therefore now present it to the enlightened public, leaving it to them to decide on the justice of my observations.

Ammoniac (diluted with water*) does not dissolve metallic copper without the contact of vital or atmospheric air, and receives not from it the slightest shade of colour; nor does it, if united with carbonic acid, show any stronger signs of attacking that metal.

Experiment I. I filled a two-drachm phial with ammoniacal water, which not only made no effervescence with the acids, but did not even disturb

* The ammoniac diluted with water is here to be understood of that which is pure and of that which is carbonated.

the

the transparency of lime-water*. I introduced two laminæ of copper, each weighing about a drachm, and stopped the phial with a cork so closely, that between the liquid and the cork I could scarcely perceive a few bubbles of air of the size of a lentil†. Twenty-four hours after, the liquid was colourless, and the pieces of copper preserved all their metallic brilliancy.

Experiment II. I made the like trial with carbonate of ammoniac, and with a similar result.

Experiment III. I poured the ammoniac in which I had immersed the laminæ of copper in Exper. I. into a small glass vessel. Twenty-four hours after, it had acquired a weak blue colour, which did not become deeper afterwards.

Experiment IV. I poured the carbonate of ammoniac in which I had immersed the laminæ in Exper. II. into a small glass. Twenty-four hours after, it had not acquired any colour, and on the following days it did not assume the least shade of blue.

According to these two experiments, carbonate of ammoniac, without the introduction of air, produces no greater effect in dissolving copper than ammoniac. It would even be inferred from the IIId and IVth Experiments, that the latter is more effectual. I had purposely employed laminæ of copper and not filings, that I might not pour off any of the metal with the liquid; and even supposing that no part of it passed, the ammoniac

* These two negative trials were necessary, because the positive signs show the presence of carbonic acid.

† This precaution was always taken, and in some experiments it happened that I pushed the cork into the full bottle, so that no air remained in the vessel.

might

might have diſſolved a little of the copper without being coloured by it, and it retained its original colour, when the copper, diſſolved by it being ſlightly oxydated, became more ſo by the air. I do not deny the poſſibility of this, ſince we know that in ſome caſes the ſolutions of copper in the muriated acid take place without colour*. Yet, as I obſerved no colour in the carbonate of ammoniac after pouring it off, nor in the other experiment with ammoniac, I am led to think, that in the third experiment perhaps ſome duſt of poliſhed copper detaching itſelf may have been poured off with the liquid, and may have been afterwards diſſolved by the contact of the air.

Experiment V. and VI. I then proceeded with ammoniac, and with carbonate of ammoniac, as in Experiments I. and II. but left the veſſels open, and not full, that the liquids might have a larger ſurface. Both of them ſoon appeared bluiſh, and 48 hours afterwards of a deep obſcure blue; the laminæ of copper were almoſt entirely diſſolved, and the reſt of a black, approaching to a brown, without any metallic brilliancy. I cannot ſay I perceived any remarkable difference in the two ſolutions; even in the ammoniac, the blue colour was 24 hours after already ſo much more intenſe than in the IIId experiment, that it might be concluded, that, if the ammoniac diſſolves a part of the copper without the action of the air, it will diſſolve much more with its aſſiſtance; which is neceſſary not only to produce the blue colour, but the ſolution itſelf. Ammoniac diſſolves the

* See the obſervations of Meidingez, in "Crell's Chemical Annals, 1792, p. 355;" and thoſe of Prouſt, in "Scherer's Chemical Journal."

blue

blue and grey oxyd of copper even without the contact of air, and produces a deep obscure blue* colour.

Experiment VII. After having dissolved copper in a metallic state by the nitric acid, I precipitated from this blue solution, saturated with ammoniac, an oxyd of copper of a blue-grey-green. As soon as the precipitant was in excess, the precipitate was redissolved, and a further addition gave to the whole, which was perfectly clear, a fine dark blue colour.

Experiment VIII. I dissolved metallic copper to saturation by the aid of heat in strongly-fuming muriatic acid; the solution was brown and destitute of transparency. After remaining some days exposed to the air, its brown colour changed to a dark green, and under that colour it became perfectly clear. I diluted it with water, and precipitated a yellowish green oxyd by ammoniac. More ammoniac being added with excess redissolved this precipitate, and left a residuum (the yellow oxyd of copper), and the blue colour appeared.

I have often repeated these experiments (7 and 8), and they were the ground of my doubts relative to the assertion, that the carbonic acid is necessary to enable ammoniac to dissolve oxyd of copper. But could ammoniac instantaneously extract from the atmosphere as much carbonic acid

* I am acquainted with the experiments of M. Reineke (see Crell's Chemical Annals, 1800, § 110,) on the indissolubility of the oxyd of copper in pure pot-ash; but there are so many facts to show how little we can depend on analogy in chemistry, that we could by no means thence infer the impossibility of dissolving that oxyd in ammoniac.

as

as on that fuppofition is neceffary to diffolve fo much oxyd of copper as it here diffolves? Yet Dr. Hahnemann pretends, and no doubt with reafon, that the contact of the air muft be avoided to prevent the poffibility of an element being extracted from the atmofphere.

Experiment IX. I then put about two grains of very pure oxyd of copper in a phial, containing two drachms, and filled with ammoniac; I immediately clofed the whole, fo that there was no accefs to the air. In a few minutes, the ammoniac affumed a deep blue colour; and the next day the oxyd of copper was entirely diffolved, with only a flight refiduum, rather brown, probably of argil, that was attached to the blue of copper.

Experiment X. Although I had, in each cafe, kept the ammoniac as much as poffible from the contact of the air, and after filling the phial, and putting in the oxyd of copper, had immediately well-corked the whole, yet, to remove any fmall quantity of carbonic acid that might have entered, I thought it right to add to it lime, made in a glafs tube, which contained about fourdrachms. Of this lime I took 60 grains, filled a tube with ammoniac, and, having ftopped it clofe with my thumb, fhook it during a quarter of an hour; I then introduced a few grains of green oxyd of copper precipitated by ammoniac from a folution with the muriatic acid, and again ftopped the tube with my finger, fo that it was filled with ammoniac oxyd and lime, and without a bubble of air. Yet the oxyd of copper was prefently diffolved, with the exception of a little yellow refiduum; and, as this laft, as well as the lime, depofited a fediment after a few minutes,

minutes, I diſtinctly ſaw the blue colour of the ammoniac ariſe.

Experiment XI. Afterwards, according to the proceſs of Dr. Hahnemann, I put two grains of ſulphate of copper into a phial full of ammoniac, and holding about two drachms, as the ammoniac alone ought to diſſolve it: if the oxyd of copper is inſoluble in ammoniac, the phial being corked, and ſcarcely containing a bubble of air, the oxyd of copper ought to have been precipitated, and the ammoniac have remained colourleſs; if, on the contrary, oxyd of copper is ſoluble in ammoniac, then the ammoniac that is in exceſs ought to diſſolve the precipitate ſcarcely formed, and the liquor aſſume a blue colour. The fact proves the latter caſe: the ſulphate of copper always diſappeared without ſhewing any precipitate; and the liquor aſſumed a blue colour, with the exception of ſome yellow flakes, which I perceived after a few days.

Experiment XII. I was anxious to ſee what would become of the green oxyd of copper, which contained carbonic acid, after I ſhould deprive it of the latter. I heated a morſel of copper ore, a portion of which had been diſſolved in the nitric acid, with appearance of the blue colour in the ſolution, and a proportionable diſengagement of carbonic acid gas; I heated it, I ſay, in a coppel, ſo much that the whole turned quite black, and that another aſſay of the ſame being put into the nitric acid was only ſlowly and partially diſſolved, and without diſengagement of gas. I afterwards put a freſh aſſay of it into a phial filled with ammoniac. No perceptible ſolution took place, and the liquor remained colourleſs. After 24 hours I poured it into a ſmall glaſs, where it did not be-

come blue, though the veſſel continued open. I poured freſh ammoniac into the oxyd of copper in the phial, corked it well, and again perceived neither ſolution nor colour; but after the veſſel had continued open 24 hours, the liquor always became blue, though much ſlower than with metallic copper.

All theſe experiments ſeem to demonſtrate the poſition I have laid down; and I ſhould be glad to learn in what I could be deceived, or why theſe experiments ſhould not be perfectly concluſive. At preſent, I am perſuaded, the non-colouration of the ammoniac, with metallic copper, in a veſſel completely filled and accurately cloſed, ariſes not from a want of carbonic acid but of oxygen*, which muſt either be in the copper itſelf or attracted from the atmoſphere, when copper gives a blue colour to ammoniac. In fact, the oxygen muſt be communicated mediately by the ammoniac to the copper, becauſe the latter at bottom is not in contact with the air: the ſame proceſs muſt take place as in the coagulum of the blood, which becomes red by the aid of atmoſpheric air, although itſelf enveloped in ſerum; or as happens to iron, when, under oxyd of lead in an iron ſtove, all the oxyd of lead reſumes its original ſtate, although the upper part and middle are not in contact with the lead. It muſt likewiſe be allowed, as I have alſo here admitted, that, from the blue colour of the ammoniac, the ſolution of the oxyd of copper may be inferred, but not that from its remaining colourleſs, the non-ſolution muſt follow.

* Compare herewith the information given on this ſubject by Bergman, in his treatiſe "De Attractionibus Electivis," § 59, opuſc. 3 p. 389.

LXXI.

LXXI. *On the Phenomena of Capillary Tubes.* *By M.* Milon.

FROM THE *JOURNAL DE PHYSIQUE*.

THE phenomena of capillary tubes are as follow; 1ſt. If one of theſe tubes be plunged in a fluid, ſuch as water, alcohol, &c. the fluid riſes within it above its external level; and this elevation is in direct proportion to the ſmallneſs of the tube. 2d. But if it be plunged in mercury, inſtead of riſing as above deſcribed, it is depreſſed; and this depreſſion is alſo in direct proportion to the ſmallneſs of the tube.

In times, when the ſciences were cultivated with leſs accuracy than at preſent, and when chemiſtry in particular was not enriched with that beautiful theory which now forms its baſis, philoſophers long debated on the cauſe of this phenomenon now generally attributed to molecular attraction; the only point on which they differ being, that ſome admit both the phenomena of aſcenſion and thoſe of depreſſion, while others only admit thoſe of aſcenſion.

The celebrated Hauy, in the third volume of the firſt part of the *Séances de l'Ecole Normale*, page 40, after having deſcribed the firſt of the above-mentioned phenomena, ſays, "Mercury on the contrary remains below the level, and its depreſſion is in inverſe proportion to the diameter of the tube. But theſe effects preſuppoſe that the tube is applied without preparation; for we ſhall preſently ſee, that by means of certain precautions the elevation of mercury above the level may in

like manner be obtained." And in ſupport of this aſſertion, he quotes, page 50 of the ſame volume, an experiment made at Metz, by Citizen Caſbois, from which it appears, that the depreſſion of the mercury ariſes merely from the moiſture contained in the mercury and the tubes employed; which moiſture, interpoſing itſelf between the mercury and the glaſs neutralizes the attraction which the glaſs may have for that fluid; and that, on removing this moiſture, mercury is governed by the general law above ſtated, and riſes in capillary tubes in the ſame manner as other fluids.

On the other hand, Citizen Libes, in his new and excellent *Traité élémentaire de Phyſique*, vol. II. page 23, &c. explains the depreſſion of mercury by obſervations to the following effect: "That although the glaſs may have ſome attraction for the mercury (a fact, which he proves, by a very ſimple experiment), the mutual attraction of the molecules of this fluid for each other is more conſiderable." This is proved by the following experiment: if a globule of mercury adhering to a plate of glaſs be preſented to a maſs of that metal, the globule abandons the glaſs and unites with the mercury. Hence he draws ſeveral very juſt inferences.

This contrariety of opinions muſt neceſſarily give riſe to doubts, which it is important to clear up. The following is the proceſs which has contributed to fix my opinion on this ſubject.

I firſt made the ordinary experiment with my pure mercury, when the fluid was as uſual depreſſed. I then poured the mercury into a ſmall long-necked mattraſs, and expoſed it to the fire of a ſimple furnace by means of a ſand bath. I placed this apparatus out of a window, which I ſhut

ſhut in order to obſerve what paſſed without expoſing myſelf to the dangerous influence of the mercurial vapour. After a while the mercury began to boil, and then becoming volatile, it collected about the ſides of the mattraſs in ſmall drops, which fell down again in proportion as their weight increaſed. This continued about a quarter of an hour, after which I thought I might conſider the mercury as deprived of all moiſture. I then heated to a white heat the capillary tubes I intended to employ, and, having only allowed time for theſe as well as the mercury to return to the temperature of the place where I performed the experiment, I plunged them in the mercury thus deprived of its moiſture, and obſerved the ſame depreſſion as in my former experiment.

To aſcertain that the depreſſion of the mercury did not ariſe from the moiſture, that might remain in the tubes, notwithſtanding the precautions I had taken, I placed two of theſe tubes perpendicularly in the mercury, and, approximating them to each other, I perceived the ſame reſult as before; for the nearer they approached, the more was the mercury depreſſed between them.

It may be replied, perhaps, that the mercury had already attracted the humidity of the air. But I would anſwer, 1ſt. That the weather was then very dry; a circumſtance by no means indifferent. 2d. That although the attraction of mercury for a certain portion of moiſture may be conſiderable, it is not ſudden; and that its union with ſurrounding water only takes place after a conſiderable interval of time, as, for inſtance, eight or ten hours, and that I was careful to perform the experiment with great diſpatch.

Hence

Hence I think I am authorised to believe, that the depression of mercury is constant, that the moisture of the mercury makes no alteration in this phenomenon which is peculiar to it, and that, if it rose above the level in the experiment of Citizen Casbois, which, though very different from mine as to the process pursued, ought to lead to the same result, the success of that experiment certainly depends on peculiar circumstances, which it would be well to examine: for, if the phenomenon of ascension took place with mercury when well purified from water, it would follow, that it has a stronger affinity to glass than to itself, which is contrary to experience.

LXXII. *List of Patents for Inventions, &c.*

(Continued from Page 360.)

John Donaldson, of the city of Bristol, Glass-manufacturer; for a method of making all kinds of glass in a more expeditious manner than hitherto attempted. Dated March 5, 1802.

Obadiah Elliott, of the parish of St. Mary, Lambeth, Surrey, Coach-maker; for an Eccentrical anti-labourist spring curricle-bar, for one or more horses, upon a new and improved construction. Dated March 9, 1802.

Thomas Loud, of Hoxton, in the parish of St. Leonard, Shoreditch, Middlesex, Musical Instrument-maker; for improvements in the action and construction of upright piano fortes. Dated March 9, 1802.

James

James Mitchell, the elder, and James Mitchell, the younger, both of the hamlet of Poplar and Blackwall, Middlesex, Rope-makers; for their farther improvements in the manufacturing of cables and hawsers.
Dated March 9, 1802.

Christopher Wilson, of the Grange Walk, in the parish of Bermondsey, Surrey, Tanner; for a method of making and obtaining a vacuum or vacuums whereby powers are gained or obtained applicable to the improvement of hydraulical, pneumatical, and mechanical machines or engines, or any others where fluids, steam, or vapour, may be used or applied.
Dated March 9, 1802.

Peter Litherland, of Liverpool, Lancashire, Watch-maker; for a mode of keeping musical-instruments in tune, and of preserving the strings from breaking.
Dated March 24, 1802.

Sebastian Erard, of Great Marlborough-street, in the parish of St. James, Westminster, Middlesex, Musical Instrument-maker; for improvements in the musical instrument called a harp. Dated March 24, 1802.

Philip James Meyer, of Great Portland-street, Middlesex; for a machine to prevent danger to persons driving, or being in curricles, single-horse chaises, or other carriages, by horses being restive, breaking or running away with such carriages, or backing, in consequence of taking fright while harnessed thereto.
Dated March 24, 1802.

James Ashworth, of Tottington, in the parish of Bury, Lancashire, Dyer and Colour-maker;

maker; for a method of making iron-liquor for the use of dyers and printers. Dated March 24, 1802.

HENRY GRANT, Esquire, of America-square, in the city of London; for a machine for the purifying and clarifying of water, whereby the most putrid or foul water may be rendered perfectly sweet and clean. Dated March 24, 1802.

RICHARD TREVITHICK and ANDREW VIVIAN, of the parish of Camborne, Cornwall, Engineers and Minors; for methods of improving the construction of steam-engines, and the application thereof for driving carriages, and for other purposes. Dated March 24, 1802.

JOHN WILLIAMS, of Portsmouth, Hampshire, Gentleman; for a method or means of disengaging horses from carriages. Dated March 24, 1802.

EDWARD MASSEY, the younger, of Stanley, in the parish of Stoke-upon-Trent, Staffordshire, Watch-maker; for an instrument or apparatus for taking soundings at sea with more certainty and correctness than heretofore, and for other nautical purposes, and matters connected with, or relating to, navigation. Dated March 24, 1802.

THOMAS CONNOP, of Manchester, Lancashire, Machine-maker; for a machine for batting, opening, and cleansing, cotton, wool, and sheeps-wool. Dated March 30, 1802.

END OF VOL. XVI;

BEING THE CONCLUSION OF THE FIRST SERIES.

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SIXTEENTH VOLUME.

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L

Lester,

Parmentier,

Somerville,

Water,

ERRATA.

Number XCI. page 58, line 14, for *Magnesia* read *Manganese*.
XCVI. 280, 7, for *diluted* read *distilled*.

Printed by NICHOLS and SON, Red-Lion-Passage, Fleet-Street.